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# MOLD CLEANING: New Process

● A NEW PROCESS for cleaning molds has just been announced jointly by Finley B. Hess, Brockway Glass Company president, and William J. Himmel, president of Electrocleaning, Inc., Cleveland. The operation, which has been under test for three years at Brockway's Freehold, N. J., plant, is simple, very effective and, most important, uses chemical baths which have no toxicity in regard to the molds, or the operator.

As a matter of fact, the Freehold plant is probably the only glass container manufacturer in the world today which has no vapor or sand blast equipment and does not use any acids in its cleaning baths.

Based on the principles of electroplating, the Electrocleaning Process, as it is called, consists of an elliptical monorail system from which are suspended standard plating machine basket conveyors. Each basket will hold two molds and related equipment. Five special chemical baths are arranged in series along one side of the ellipse.

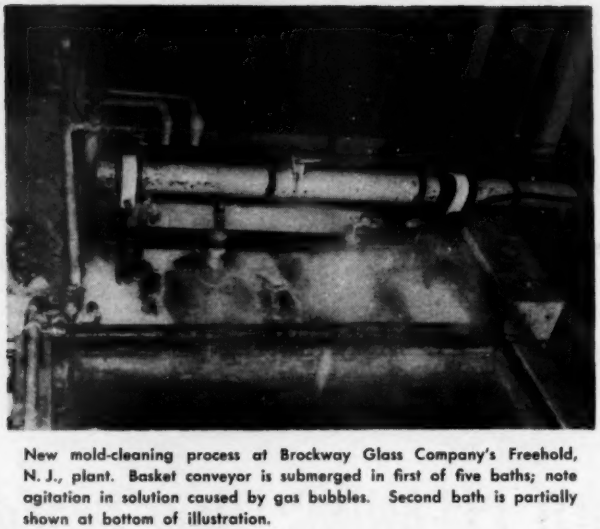
Operation is simple and straightforward. After the molds are placed in the baskets (one or more basket conveyors can be put into operation at a time), the operator pushes the starter button and each basket in turn automatically travels in a horizontal direction above the baths. At a prearranged point, the first basket, then the second, third and following baskets, stops its forward motion, lowering itself (and the molds) in sequence into the first bath for a prescribed length of time; then the second, third, fourth and fifth baths. The cleaning cycle is completed for any one basket in 25 minutes. It is not necessary for the operator to stand by; he is free to perform other general work in the plant area.

When the molds have completed the cycle, the operator transfers them to a bench and brushes each one with a soft wire rotary brush to remove the loose, powdery dust. If the molds are going to be used again within a short time, they are stored without further treatment, otherwise they are coated with a rust preventive. All mold equipment at Freehold is cleaned as the glass container job is completed; repaired, stored and always ready for use at a moment's notice.

We observed a large number of these molds and noted that some had the original marks of the machinist although they had been washed many times; the vent holes were clean and distinct (no redrilling necessary for the life of the mold); the contours were sharp and precise (see cover illustration); the minutest detail was sharp and clear-cut; and the edges of each mold cavity felt as smooth and true as a taut wire.

This is the only mold-cleaning process that Brockway has ever used at Freehold (the plant became operational three years ago), and it can take care of the requirements of one 180-ton tank. During that time, the Electrocleaning Process has cleaned successfully all molds, and it has never been found inadequate for any condition prevailing at that plant.

Herbert C. Snyder, production engineer, points out that



New mold-cleaning process at Brockway Glass Company's Freehold, N. J., plant. Basket conveyor is submerged in first of five baths; note agitation in solution caused by gas bubbles. Second bath is partially shown at bottom of illustration.

the process is operated on only two of the three shifts each day, and even then is not working at capacity.

### Principle of Operation

In their order of use, the baths consist of:

1. alkaline degreasing solution;
2. warm water rinse;
3. alkaline oxide-and-silicone removal solution;
4. warm water rinse; and
5. hot water rinse.

The reason for the heat in the last rinse is to speed up the drying of the mold after the washing cycle has been completed.

Baths (1) and (3) each have a life of about one or 1½ months, depending, of course, on the frequency of use and the amount of dirt and sediment which collects in them. During this time, strength additions are made on the average of once a week.

When each basket dips into a bath, a contact outside the bath completes the circuit. The mold becomes the cathode (—), and a vertical carbon bar attached to the center of the conveyor paltform acts as the anode (+). Hydrogen gas is "plated" on the cathode (mold), and oxygen is liberated at the carbon anode.

Actually, what is thought to take place at the cathode (mold) is a partial "deplating" of the dirt particles; at the same time, the bubbles of hydrogen and oxygen gas agitate the solution which then physically knocks the dirt off the molds. Brockway calls this a "gas-scrubbing" action. They stress that because the solutions are alkaline, there is no eating away of the iron; nor is there the abrasive action associated with the sand blasting and vapor blasting methods.

According to Mr. Himmel (Electrocleaning, Inc.), a co-developer of the process, "Success in developing the Electrocleaning Process for glass container molds would have been impossible without the perseverance and drive of Finley B. Hess, president, and Leon F. Robertson, vice-president, of Brockway." Mr. Himmel, with Brockway engineers, developed the treatment cycle of timing, chemicals and electrical currents.

The company has now perfected the process to the point where they can offer it to the glass container industry at large. Patent applications have been filed, and plans are also currently under way to license companies to service glass container plants in foreign countries.

**ADVANTAGES OF THE PROCESS**

**a. Uses no harmful acids; mold iron is not eroded.**

**b. No abrasive action in electrolytic process; cavity surfaces are not worn away.**

**c. After hundreds of cleanings, stippled sections, whether on panels or bottom plates, are clean and sharp; they do not need constant repair.**

**d. Cleans vent holes; redrilling is eliminated. Hanger grooves are cleaned instantly.**

**e. Mold life is lengthened. No emery cloth polishing; soft wire brush does not scratch mold.**

**f. Fine engraved lettering remains sharp and clear.**

**g. Edge of mold cavity is not rounded by abrasive blast or acid cleaning; parting lines on finished ware remain obscure.**

**h. High luster is maintained on finished ware because of absence of scratches and other minute mold and blank surface imperfections normally caused by abrasive action and materials.**

**i. Mold-cleaning costs are reduced; does not require constant attention of operator.**

**j. Silicones and oxides are removed at once.**

# A.C.S. 62nd Annual Meeting

*The American Ceramic Society was founded February 6, 1899, at Columbus, Ohio, under the leadership of Edward Orton, Jr., founder and head of the first school for ceramics in the United States, at Ohio State University. It started with 15 members—"ceramic chemists or those who understand ceramic work from the scientific side and would be willing to share their information with fellow members." Today, The Society has more than 7,500 members and subscribers in 47 different countries, and publishes three monthly magazines, The Journal of The American Ceramic Society; Ceramic Abstracts; and The American Ceramic Society Bulletin.*

George H. Spencer-Strong, president, American Ceramic Society

GEORGE H. SPENCER-STRONG, vice president of the Hemco Corp., will become president of The American Ceramic Society during the 62nd annual meeting in Philadelphia, Pa., April 24-28.

A recognized authority on porcelain enameling, Dr. Spencer-Strong has been an active member of the Society since 1926. He was chairman of the enamel division in 1938-1939, counselor in 1939-1940, and trustee from 1949 to 1952. He is now counselor of the Baltimore-Washington Section.

## Glass Division Preliminary Program

Papers to be given at the Glass Division meetings are listed below:

1. **Internal Friction of Progressively Crystallized Glasses.** D. E. DAY, Pittsburgh Plate Glass Company, Fellow, and G. E. RINDONE, Assistant Professor, Ceramic Technology Dept., College of Mineral Ind., Penna. State Univ., University Park, Pa.
2. **Volatility of Lead-Borate Systems.** CHIKARA HIRAYAMA, Westinghouse Research Labs., Pittsburgh, Pa.
3. **Investigation of Structure in Lead Borate Glasses.** ROBERT L. HALLSE, Convair, Pomona, Calif., and RALPH L. COOK, University of Illinois, Urbana, Ill.
4. **Constitution of Mixed Alkali Cation Phosphate Glasses.** M. KRISHNA MURTHY, post doctorate fellow, Department of Chemistry, Ontario Research Foundation; M. JOYCE SMITH, Birmingham, England, formerly research fellow, Ontario Research Foundation; and A. E. R. WESTMAN, director of research, Ontario Research Foundation, 43 Queen's Park, Toronto 5, Canada.
5. **Glass Formation in the System Arsenic-Sulfur-Bromine.** A. DAVID PEARSON and WILLIAM R. NORTHOVER, Bell Telephone Laboratories, Murray Hill, N. J.
6. **The Dual Role of Niobium in the System $SiO_2$-$K_2O$.$Nb_2O_5$.** BH. V. JANAKIRAMA RAO, International Resistance Co., Philadelphia, Pa.
7. **Heat Conductivity Processes in Glass.** W. D. KINGERY, Mass. Institute of Technology, Cambridge, Mass.
8. **A Review of Radiant Heat Transfer in Glass.** ROBERT GARDON, Pittsburgh Plate Glass Co., Pittsburgh, Pa.
9. **Determination of the Spectral Transmission of Glass in the Temperature Range From 20°C to 1400°C, and Application of the Results to Heat Transfer Problems and to Techniques of Temperature Measurement.** H. CHARNOCK, F. J. GROVE, and J. R. BEATTIE, Pilkington Bros. Ltd., St. Helens, England.
10. **Cooling of Window Glass and Temperature Measurement by Radiation Analysis.** R. VAN LAETHEM, L. LEGER, M. BOFFE and E. PLUMAT, Union des Verreries Mecaniques Belges, Charleroi, Belgium.
11. **Overall Heat Transmission Coefficients of Amber and Green Glasses in Temperatures of the Melting Range.** S. KRUSZEWSKI, United Glass Ltd., Charlton, England.
12. **Temperature Distribution of Glass in Blank Molds of Hollow Glass Machines.** W. TRIER, Huttentechnische Vereinigung der Deutschen Glasindustrie, Frankfurt am Main, West Germany.
13. **Relations Between Heat Losses of Glass, Forming Times and Bottle Production in Blowing Machines.** W. GEIGERICH, Glashutte Heilbronn A.G., Heilbronn, West Germany.
14. **The Transfer of Heat in Glass During Forming.** D. A. McGRAW, Owens-Illinois Technical Center, Toledo, Ohio.
15. **An Estimation of the Heat-Transfer Conditions in Glass by Cinematography of Strains During Heat Treatment.** P. ACLOQUE, Cie de Saint Gobain, Paris, France.
16. **Glass Fibers; General Contrasts in Low-Melting and High-Melting Forms Based on Composition.** ALEXANDER SILVERMAN, professor and head, Chemistry, emeritus, University of Pittsburgh, Pittsburgh 13, Pa.
17. **An Analysis of Heat Flow in Soda Lime Glass.** JULIUS J. TOROK, Owens-Illinois Glass Co., Kimble Glass Div., Toledo, Ohio.
18. **A Method for the Measurement of Thermal Diffusivity to 1000°C.** WILLIAM A. PLUMMER, DONALD E. CAMPBELL, and A. A. COMSTOCK (deceased), Corning Glass Works, Corning, N. Y.
19. **The Variation of Refractive Indices and Densities in Tempered Glass.** ROBERT GARDON and S. F. WHITESIDE, Glass Research Center, Pittsburgh Plate Glass Co., Pittsburgh 38, Pa.
20. **Stress Measurements by "Mirage-Transmission" or "Mirage-Reflection" in Tempered or Bent Glass.** P. ACLOQUE, Saint-Gobain, Paris, France.
21. **The Microstructure of Soda-Lime Glass Surfaces.** R. M. TICHANE and G. B. CARRIER, Corning Glass Works, Research & Development Division, Houghton Park, Corning, N. Y.
22. **The Variation of Strength of Acid Polished Glass with Surface Area of the Specimens Tested.** CHARLES H. GREENE, State University of New York College of Ceramics, Alfred Univ., Alfred, N. Y.
23. **Fracture Velocity of Glass in the Fatigue Range.** ERROL B. SHAND, Technical Consultant, 155 Reynolds Ave., Corning, N. Y.

(*Continued on page* 232)

# DUST CONTROL in Glass Manufacturing

*by Edward F. Wilson, President,* EDWARD F. WILSON & COMPANY

● DUST CONTROL and air pollution are demanding increased attention from management, union and community officials. Giant strides have been made in the last few decades in controlling some of the worst offenders, particularly smoke and many industrial fumes. As these large-volume dust sources are eliminated or minimized, other sources, previously considered minor, have become more noticeable. Dust control methods have been, or must now be, developed for these.

The unloading of bulk raw materials and plant handling of dusty materials cause visible dust clouds in the plant and vicinity. Light discharges of stack dust other than smoke have high visibility which draws attention and causes complaints.

For the purpose of this discussion, dust is defined as any finely divided material. It may be in the form of relatively large particles which readily settle to the ground, or very fine particles which, once airborne, will float for extended periods on air currents of low velocity. Even cigarette smoke can be technically considered a form of dust under certain conditions.

Major sources of dust in the glass industry originate in the material handling operations prior to mixing; in mixing; and in subsequent handling of the mixed batch, including dusting in the tank itself.

After the batch is introduced into the furnace, dust raised by the currents of hot gasses can cause quality control problems by altering the balance of ingredients and by depositing unwanted materials on tank areas where they may fall back into the molten glass. These extracted dusts are often carried to the incandescent checkers where they will build up heavy deposits which will affect economical operation and finally necessitate shut-down for cleaning.

Some dusts are more hazardous to personnel than others, but practically any dust creates various problems when it gets out of control. Lead-bearing materials and arsenic compounds are among materials frequently handled in various glass formulations; some batch additives may contain unidentified metallic salts or other materials which can damage the human system through cumulative effect over long periods.

Most of the materials in glass batch are finely divided and dusty. Sand and cullet, which have relatively large sizes, have sufficient fines to create dust problems, and most materials are much finer in size. Sometimes the dust is an unwanted side product, where its production cannot be avoided, such as in the crushing of cullet and the surface grinding of plate glass. Production of fly ash in the boiler plant is another example of a fine, difficult-to-handle dust occurring as a side product.

Dust control may be dictated by community considerations, personnel requirements, plant equipment, maintenance needs, and quality control. Community control is often of a mandatory nature, brought about by political action when voluntary control is inadequate.

Personnel requirements can dictate control of health hazards and also draw plant safety attention to areas where high dust loading may be a contributing factor in accidents due either to lowered visibility or slipping on deep accumulations of dust. Quite often union demands from the health or working conditions standpoint enter the picture.

Equipment considerations, while often intangible, can recommend dust control in order to reduce maintenance requirements. A little-recognized cost of uncontrolled dust may be loss of production by equipment outage requiring plant or process shutdown for repair. Bearings of drive motors on essential equipment may fail from dust abrasion; conveyor bearings are subject to excessive wear in dusty locations; and switches, control systems, and electrical apparatus are readily knocked out of service by conductive or non-conductive deposits on contact points. The failure of any of these items of equipment to function can shut down the complete plant unless expensive stand-by equipment, otherwise unnecessary, is maintained for such a contingency.

Quality control requirements may point to dust control to limit excessive product rejection caused directly or indirectly by dust conditions. Dust on scale bearings accelerates wear, and sluggish or inaccurate balances make quality control difficult, particularly for critical materials where a small variation in amount causes wide variation in the product. Dusty deposits in the glass tank may break off and fall into the tank, thus contributing to the formation of stones and consequent rejection of the finished glass product.

Until recently, complete control of dust was very expensive and most control installations were only partially successful. The degree of completeness of the control system generally reflected a balance between the requirements for dust control and the costs of increasingly complete installation.

## Collecting Airborne Dust

Many difficulties are inherent in collecting dust after it once becomes airborne. Relatively large particles which remain airborne for short periods, or are carried by rapidly moving currents of air or gas, do not present too much of a problem in collection. Relatively small particles, from about 10 microns to sub-micron size, create the real dust problem. These particles must be eliminated if dust control is to be effective, for when they once become airborne they settle very slowly, even in still air, and may be carried considerable distances in relatively light air currents. They have noticeable visibility effect under certain light conditions and can create the impression of a large quantity of material when only small amounts by weight are involved. These small particles quite often carry electric charges which make them repel each other thereby hindering a collection system further.

These small particles may be collected by elaborate systems of ductwork in which are enclosed the conveying system, transfer points, mixing, and even the raw materials unloading points. Large fans of considerable power, complicated dust collectors, and storage bins are required. This method requires continuous maintenance due to the abrasive quality of the dust and the unavoidable impingement effects inherent in draw-off systems. Even after these fine dusts are collected, the problem remains how to handle them, whether they are *(1)* to go back to process or *(2)* to be disposed of because they cannot be used.

Effective separation of dust from a collection airstream is difficult, and many problems of mechanical collection are not yet completely solved; high maintenance and replacement requirements of bag type collectors, tremendous size requirements for centrifugal separators on low-micron dusts and high initial cost, difficult maintenance, and expensive power demands for electric precipitators are often prohibitive limitations in dry collection. Wet scrubbers frequently combine all of the above problems and add the difficulties of thickening and reclaiming or disposing of the liquid suspension (slurry) containing the removed particles. Stream pollution restrictions make disposal of the effluent liquid elaborate and expensive; yet this method is extremely effective for cleaning air and gases and may be the only solution in some cases.

## Preventing Airborne Dust

Since control of dust is so difficult after it has once become airborne, it would seem logical to prevent these fine particles from becoming airborne in the first place. This thought has occurred to many engineers, and various methods have been adopted. In some industries, oil is sprayed on finely divided materials (coal, for instance) to cause the fine particles to adhere to larger particles. Considerable effective control can be achieved by this method; however, two problems limit its application.

1. In many processes oil is not compatible with the materials causing dust.
2. In those places where oil can be used, the expense of treating large volumes of material is considerable.

Water sprays have been introduced into various systems to moisten the materials so as to prevent dusting. Water sprays are ineffective in controlling fine particles, although they appear to be doing some good because they may effectively wet the larger particles of dust which would normally settle quickly even without wetting.

To explain water's inability to wet these fine particles, it is necessary to examine the character of water droplets themselves. When rain falls, or water is sprayed, it forms into individual drops, each one clearly defined and held in shape by the pressures acting on its surface. Surrounding each drop is a strong film, the "surface tension," which is a mechanical property of water and is not caused by any dissolved or otherwise foreign material in the water. This film acts as a skin and is proportionately as tough as the pigskin surrounding a football. Surface tension is a property of other materials such as oil or organic solvents like alcohol, but it is much lower than that of water in most cases.

This can be demonstrated by carefully placing a drop of light oil (or alcohol) and a drop of water side-by-side on an impervious surface such as a piece of glass. The water will remain in a globule and the oil will spread out covering a much larger relative area due to its low surface tension. When sprayed on a dusty material, fine drops of water cannot be penetrated by the tiny dust particles. The dust particles do not have enough physical mass, or weight, to penetrate the surface tension of the water, and they bounce off, as a marble would bounce off a football. This same effect is demonstrated by rain falling on a dusty road; the droplets roll on the surface of dust; the small particles do not penetrate the drop. Thus it is apparent that ordinary water cannot be really effective with fine dust particles. This is further demonstrated by procedures used until recently in larger power plants. Fly ash was collected in dust collectors; but then—to remove the dust from the collectors—it was necessary to introduce the dust into a pugmill and actually grind it with water to force the fine material into intimate contact with the water. In an operation of this type, between 10 and 20 per cent, by weight, of water had to be added to the material during pugging and even then, dry spots were encountered. Hauling costs for the disposal of the wetted fly ash included hauling these large quantities of water which were added only in an effort to overcome the dustiness.

In the glass industry introduction of water, usually when the batch is mixed, has been tried by almost all manufacturers, sometimes with limited success, usually with not enough success to justify the effort required.

With the development of a class of chemical compounds known as surface active agents, more popularly wetting agents, it has now become possible to alter the physical nature of water so as to reduce the strength of the film surrounding each droplet. These surface active agents are so called because the molecules of the agent seek the surface of the individual drop (the interface) and orient themselves in such a manner that their action resembles numerous points of penetration of the film. Further, these molecules show a pronounced affinity, or attractiveness, toward particles which may come in contact with droplets. Only very small quantities of these

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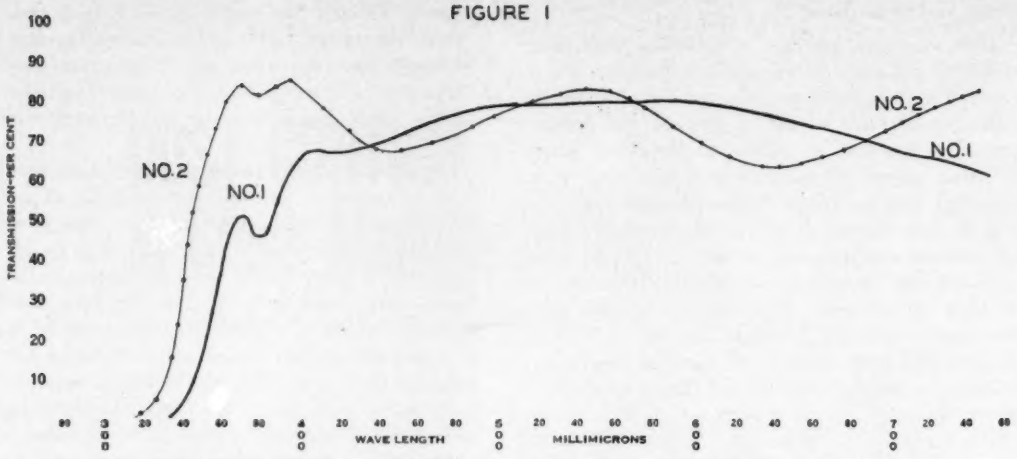
FIGURE 1




Spectral transmission curves of faint green glass (No. 1) and Georgia green glass (No. 2). Thickness equals 10 mm.

# SPECTRAL TRANSMISSION CURVES and Color Characteristics of Green Container Glasses*

*by W. R. Lester,* CHIEF GLASS TECHNOLOGIST, EMHART MANUFACTURING COMPANY, HARTFORD DIVISION, HARTFORD, CONNECTICUT

● IN 1942, SHARP[1] REPORTED the spectral transmissions of a number of colored container glasses that were being manufactured at that time. In Sharp's report, particular reference was made to the use of colored glasses for manufacture of light-protective containers.

In recent years, two types of specifications for colored container glasses have become prominent and of importance both to manufacturers and to consumers.

The first concerns the absorption of certain spectral regions by glasses. Specifications of this type generally are patterned after the definition given by the United States Pharmacopoeia[2] for "light-resistant" containers. In this definition, a "light-resistant" container is defined as one composed of substance which, in a thickness of 2 mm., transmits no more than 10 per cent of the incident radiation of any wavelength between 290 and 450 $\mu$, and which transmits no more than this limit through the least thickness occurring in the container wall. A specification patterned after this definition defines the

*Presented At: Twentieth Conference in Glass Problems, University of Illinois, Urbana, Illinois, December 11, 1959.

Spectral transmission curves of regular emerald green glass (No. 3), dark regular emerald green glass (No. 4) and ultra-violet absorbing green glass (No. 8). Thickness equals 2 mm.

FIGURE 2

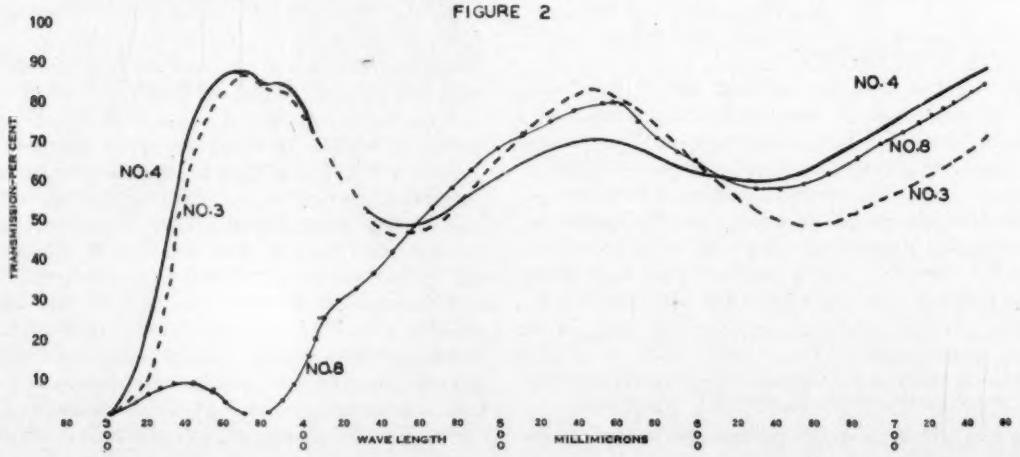
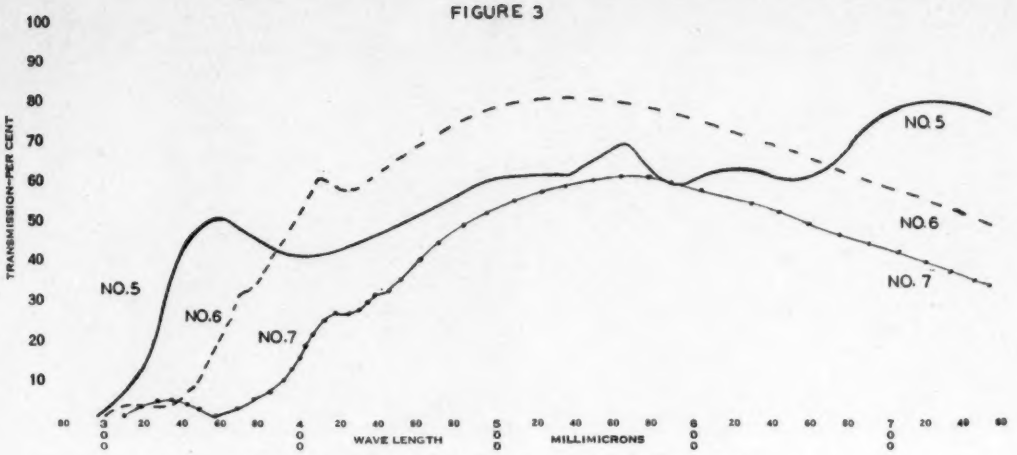


FIGURE 3




Spectral transmission curves of dark green glass (No. 5) and iron-manganese green glasses (Nos. 6 and 7). Thickness equals 2 mm.

range of wavelength and the percentages of absorption but does not define the color characteristics of the glass.

Non-color specifications may be applied also to the infrared. For example, inspection devices for inspecting the contents of containers (and which use infrared radiation as their "light" source) require a glass that transmits a substantial portion of the infrared.

The second type of specification concerns the color characteristics of a glass. This type of specification is needed when more than one glass manufacturer supplies colored containers to a single user. Color is specified numerically by the Hardy color coordinates designated Dominant Wavelength, Purity, and Brightness in terms of a standard illuminant. The numerical values are calculated from data obtained in development of a spectral transmission curve. Examples of color specifications are given for emerald green and light green in Table I.

The green glasses examined by Sharp[1] were typical, and showed a wide variety of spectral transmission curves, but the color characteristics of the glasses were not given. It is the intent of this survey to present the color values with the spectral transmissions.

## Glasses Examined; Methods of Measurement

The green glasses presented were selected as typical of commercial production of the past two years. The glasses were produced in the United States, Canada, South America, England, and Continental Europe. Each color selected for the survey was considered typical of its particular type or shade, but of course, it is understood that numerous variations could, or do, exist.

The spectral transmissions were measured with a Beckman, Model DU Spectrophotometer. Ground and polished samples of measured thickness were used. The Vaughan slide rule[3] was used for translating the measured transmission values to glass thicknesses of 2 mm. and 10 mm. From the calculated curves, the color characteristics were determined by use of the Hardy procedure of "ten selected ordinates" using "illuminant C" as reference. The colors are thus described in terms of dominant wavelength, purity and brightness.

The color characteristics, and the percentage transmissions at 1050 $\mu$ for ten typical green-colored glasses, are given in Table II. The corresponding transmission curves are presented in Figs. 1 to 4. In most cases, values

Spectral transmission curves of amber green glasses (Nos. 9 and 10). Thickness equals 2 mm.

FIGURE 4

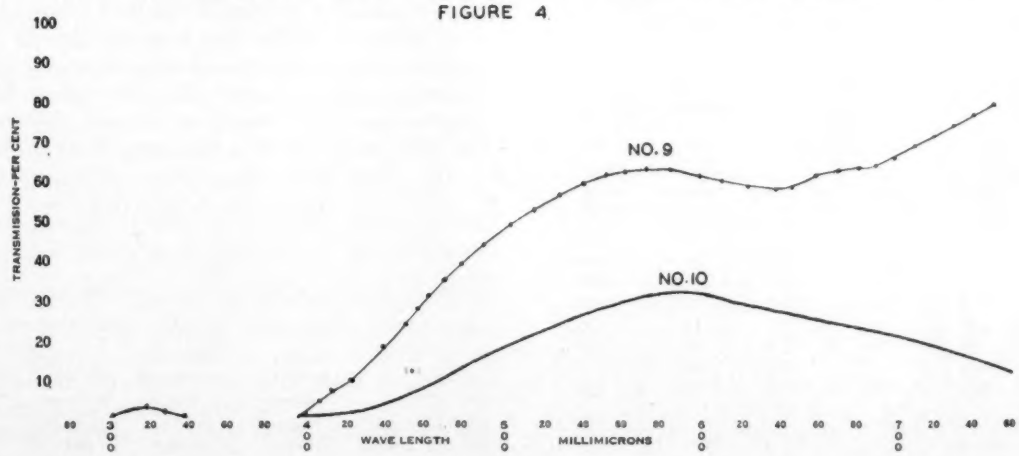


Table II

COLOR CHARACTERISTICS AND TRANSMISSION AT 1050 $\mu$ FOR TYPICAL GREEN-COLORED GLASSES

| Glass No. | Glass Color | Dominant Wave Length, $\mu$ Thickness | | Purity % Thickness | | Brightness % Thickness | | Transmission At 1050 $\mu$ % Thickness | |
|---|---|---|---|---|---|---|---|---|---|
| | | 2 mm | 10 mm | 2 mm | 10 mm | 2 mm | 10 mm | 2 mm | 10 mm |
| 1 | Green Tint | ..... | 565 | ..... | 4.7 | ..... | 79.3 | ..... | 47.3 |
| 2 | Georgia Green | ..... | 530 | ..... | 3.4 | ..... | 75.1 | ..... | 75.2 |
| 3 | Regular Emerald Green | 556 | 554 | 16.5 | 68.8 | 71.3 | 31.9 | 73.5 | 30.8 |
| 4 | Dark Emerald Green | 564 | 563 | 11.0 | 47.3 | 65.6 | 17.6 | 84.4 | 95.5 |
| 5 | Dark Green | 567 | 567 | 11.5 | 49.0 | 62.2 | 13.7 | 66.2 | 18.6 |
| 6 | Burgundy Green | 559 | 557 | 7.0 | 30.0 | 76.6 | 37.2 | 30.6 | 0.4 |
| 7 | Champagne Green | 566 | 565 | 20.0 | 68.4 | 57.5 | 9.1 | 15.5 | 0 |
| 8 | U.V. Absorbing Green | 561 | 557 | 20.5 | 68.0 | 71.5 | 28.0 | 91.6 | 89.7 |
| 9 | U.V. Amber Green | ..... | 570 | ..... | 76.6 | ..... | 14.5 | ..... | 91.0 |
| 10 | Amber Green | 573 | ..... | 62.9 | ..... | 25.9 | ..... | 4.3 | ..... |

for 2 mm. and 10 mm. thicknesses are given. The few exceptions are those where the color characteristics of a 2 mm. thickness approach those of a "colorless" glass or where the color characteristics for a 10 mm. thickness approach those of a "black" glass.

A study of the data in Table II indicates that, as a "family", green glasses represent a wide variety of values. A study of the spectral transmission curves and of the transmissions at 1050 $\mu$ shows the wide range also.

## Detailed Comments

The color of faint green glass, Table II, No. 1, and Fig. 1, normally is produced by iron oxide alone. As would be expected from a consideration of the different colors produced by iron, the state of oxidation of the iron determines both the color characteristics and the transmissions in the infrared (1050 $\mu$) and in the ultraviolet regions. Absorption in the ultraviolet (320 to 400 $\mu$) range is relatively small because of the low concentration of iron in the glass.

The Georgia green glass Table II, Glass 2 and Fig. 1, usually is colored by a combination of iron, chromium and cobalt oxides. Glasses of this type are nearly all of the same color and show nearly the same percentage transmissions at 1050. This is expected, because of established and enforced color specifications.

Table III

EXAMPLES OF ULTRA-VIOLET ABSORBING EMERALD GREENS (1959)

10 mm. Thickness

| Sample No. | Dominant Wave Length, $\mu$ | Purity Per Cent | Brightness Per Cent | Transmission at 1050 $\mu$ | Ultra-Violet Cutoff, $\mu$ |
|---|---|---|---|---|---|
| A | 554 | 52.0 | 25.1 | 90.7 | 400 |
| B | 555 | 59.0 | 28.5 | 90.6 | 390 |
| C | 557 | 62.5 | 31.7 | 90.2 | 400 |
| D | 557 | 68.0 | 28.0 | 89.7 | 400 |
| E | 558 | 50.6 | 31.7 | 91.0 | 400 |
| F | 559 | 58.6 | 30.0 | 90.5 | 400 |
| G | 560 | 71.7 | 31.6 | 89.2 | 400 |
| H | 563 | 79.7 | 27.8 | 90.0 | 400 |
| Regular Emerald Green Specifications | | | | | |
| | 554-558 | 58-74 | 30-40 | ..... | ..... |

The regular emerald green glass, Table II, Glass 3 and Fig. 2 is normally colored by the use of chromite ($FeO{\cdot}Cr_2O_3$) and small proportions of cobalt. The color characteristics of emerald greens are similar because of established specifications, but the transmissions in the infrared (1050 $\mu$) shows a very wide spread of values, explained by differences in the state of oxidation of the iron. The relatively high transmission in the ultraviolet region (300 to 400 $\mu$) which persists in spite of the higher concentration of colorants (approximately 0.2 per cent $Cr_2O_3$ and 0.2 per cent $Fe_2O_3$) is caused by the reducing conditions which normally exist.

Glass No. 4 of Table II and Fig. 2 is classed as a "dark" emerald green. It illustrates the observation that merely shifting the Dominant Wavelength toward the yellow and making the glass "darker", i.e., decreasing its brightness, does not necessarily change the transmission in the ultraviolet. The transmission curve shows appreciable transmission in the 300 to 400 $\mu$ region even though the brightness has a low value.

The colorants used for the very dark green glass, Table II, Glass 5 and Fig. 3 were not determined. This glass is employed frequently in very thick-walled containers. The color data given in Table II shows the difficulty of predicting the ultraviolet absorption of a thin (2 mm) piece of glass by a visual examination of a thick (10 mm) piece of the glass. The brightness data for the 10 mm thickness suggests zero transmission throughout the 300 to 400 $\mu$ region for while this color characteristic approaches that of a "black" glass, in a 2 mm thickness, this glass shows a high transmission in the visible, and an appreciable transmission in the ultraviolet region.

(*Continued on page* 232)

Table I

TYPICAL SPECIFICATIONS OF COLOR CHARACTERISTICS FOR LIGHT GREEN AND EMERALD GREEN GLASSES

| Glass Color | Standard Thickness | Dominant Wave Length $\mu$ Range | Purity % Range | Brightness % Range |
|---|---|---|---|---|
| Georgia Green | 10 mm. | 515-545 | 2.5-5.0 | 70-80 |
| Emerald Green | 10 mm. | 554-558 | 58-74 | 30-40 |

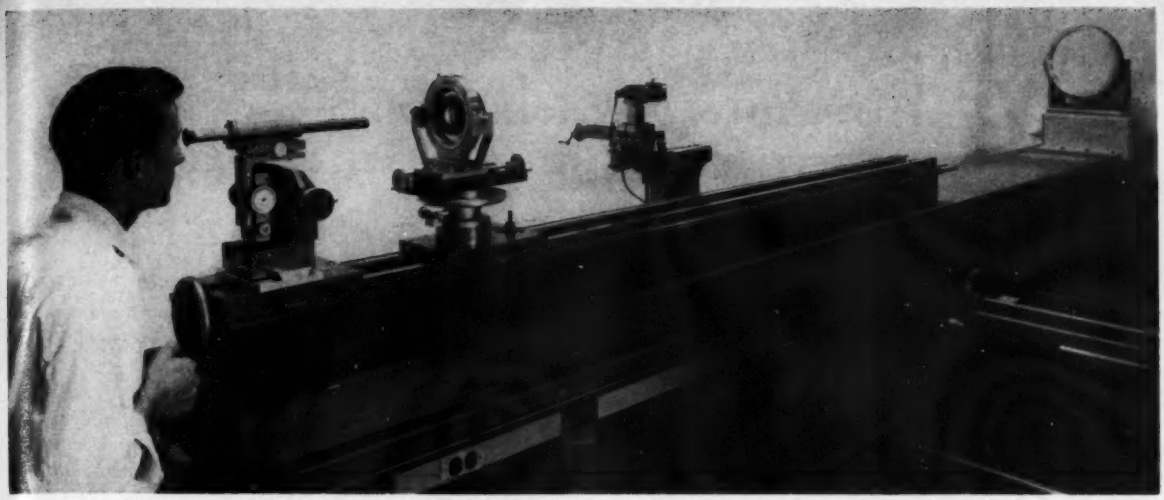


FIG. 1. The nodal slide optical bench used at the National Bureau of Standards. L. to r.: Viewing microscope for measuring the transverse displacement of the image formed by the lens, nodal slide holding the lens under test; target reticle holder and illuminating system; parabolic mirror.

# EVALUATING LENS DISTORTION

*Improved performance for photogrammetric lenses can be achieved when distortion is evaluated with the nodal slide bench, according to a recent National Bureau of Standards study. The investigation showed that when possible errors of adjustment are taken into account, accuracy in measuring distortion can be increased by a factor of 10. These results may help to broaden the applications of photogrammetry, which is presently used in planning large-area constructions.*

INCREASED ACCURACY in distortion values for photogrammetric lenses can be achieved with the nodal slide bench, according to a National Bureau of Standards study, partially supported by the U. S. Air Force.[1] An examination of the step-by-step process used with this instrument discloses that possible errors in adjustment can have an appreciable effect on the final values obtained for distortion.

When the magnitudes of these errors are ascertained, distortion values formerly difficult to determine more closely than to the nearest 20 microns are now determined to within two microns. These results may help to point the way to additional applications for photogrammetry, which now is widely employed in planning large-area constructions such as new roads and highways.

The nodal slide bench, one of the first instruments developed for measuring the optical constants of lenses, has provided an adequate method for evaluating lenses with moderate amounts of distortion. However, higher accuracy has been sought to evaluate the so-called "distortion-free" lenses used in photogrammetric mapping. Even a small amount of uncompensated distortion in these lenses may not only influence the relative location of separated objects on a map but may also produce a variable photographic scale. In an effort to obtain increased accuracy with the nodal slide method, F. E. Washer and W. R. Darling, of the Bureau's optical instruments laboratory, undertook an extensive study of the effect possible errors of adjustment could have on the final values observed for distortion.

The distortion present in a series of lenses was first evaluated with the nodal slide. This movable assembly on an optical bench holds the lens under test, and when the lens is properly aligned, the axial image formed of an illuminated target reticle coincides with the object plane of a viewing microscope. For an ideal lens, rotated through the same angle to the right and left of the original setting, the values found should be equal. However, in the lenses tested some asymmetry was generally noted.

Through a mathematical analysis of the measurements made, three principal factors were identified which contributed to the asymmetry. They were:

1. Misalignment of the collimator (parabolic mirror and illuminated target reticle) with respect to the bench ways;
2. Transverse displacement of the rear nodal point of the lens from the center of rotation of the nodal slide;
3. Angular deviation arising from prism effect on the lens combined with a compensating transverse displacement of the nodal point.

Even though all three factors may be present simultaneously, it was possible to isolate each one and compute its magnitude separately. The values thus obtained were then compared with the values previously derived, to check the consistency of the initial set of observations. It was found that if the observed values coincide with the computed values, or if the asymmetry is a smooth function of the angle through which the lens is rotated, the initial measurements are self-consistent, and can be relied upon to yield highly accurate values of distortion.

[1] Factors Affecting the Accuracy of Distortion Measurements Made on the Nodal Slide Optical Bench, by Francis E. Washer and Walter R. Darling, J. Opt. Soc. Am. *49*, 517 (1959).

# RUSSIAN TRANSLATIONS OF INTEREST TO THE GLASS INDUSTRY

**Complete separation of the gas spaces of the melting end and the drawing chamber**

This separation is advocated by A. N. Orlov in *Steklo i Keramika* (*Glass and Ceramics*) *15*, No. 1, 27 (1958).

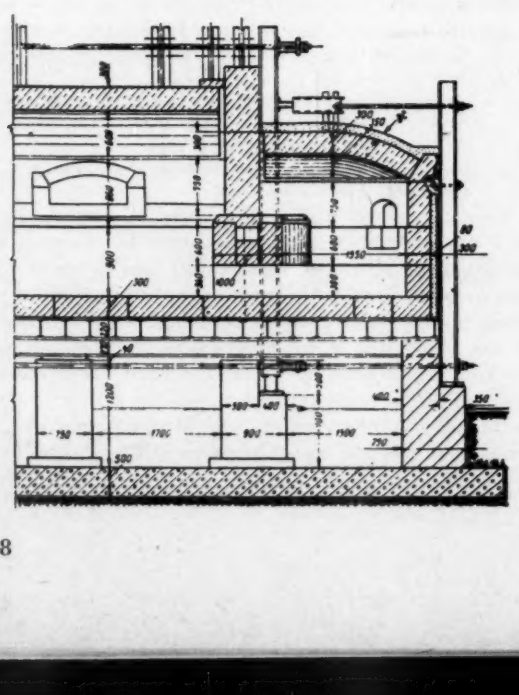
A glass furnace, with the melting end of 35 square meters, produced (on an IPL machine) 9000 to 9500 one-liter bottles per day, and the reject amounted to 40-50 per cent. Then the furnace was rebuilt as indicated in the Figure (all dimensions are in millimeters). The working end was diminished so that the glass removed reached 8 to 10 metric tons per square meter in 24 hours, and its walls, arch and feeder were heat-insulated. A solid dynas wall, 400 mm. thick, with two small openings (usually closed), was erected in the gas space between the melting and the working end. See Fig. 1 and 2.

As soon as the action of the gases of the melting end on the melt in the working end ceased and the temperature uniformity of the working end was improved by insulation, the production of acceptable goods rose. In the first year after the reconstruction, the average daily output was 15,829 bottles. The waste was 12-15 per cent. Later the wall thickness was raised to 500 mm., and the furnace was overhauled, after which the daily output increased to 17,470.

Then another furnace of the same plant was similarly rebuilt. It produced half-liter bottles. The daily output was 47,000 before and 52,000 to 53,000 after the installation of a wall between the two ends of the furnace.

In a footnote, the editor of *Steklo i Keramika* draws the attention of the readers to the "unitmelters" introduced by the Hartford Glass Co., in which the melting and the working ends are separated, and high efficiency is achieved.

FIG. 1



**Enrichment of Gas in Glass Furnaces**

Addition of liquid fuel to gas in some circumstances is advocated by N. A. Zakharikov and A. I. Rozanskii in *Steklo i Keramika (Glass and Ceramics) 15*, No. 1, p. 4 (1958).

When a gas burns with a colorless flame, addition of tar or goudron renders the flame luminous and improves the utilization of heat in the furnace. Such additions are useless when the gas already contains sources of carbon particles; thus, non-purified producer gas from coal needs no enrichment with liquid fuel.

The liquid should be injected into the hot vertical channel of the regenerator. It is dispersed with steam. The quantity of carbon particles produced by unit weight of goudron is smaller the greater the expenditure of steam; hence, the amount of steam should be just sufficient to accomplish spraying. The ratio of 0.2—0.4 (mass of steam to mass of liquid fuel introduced) is recommended.

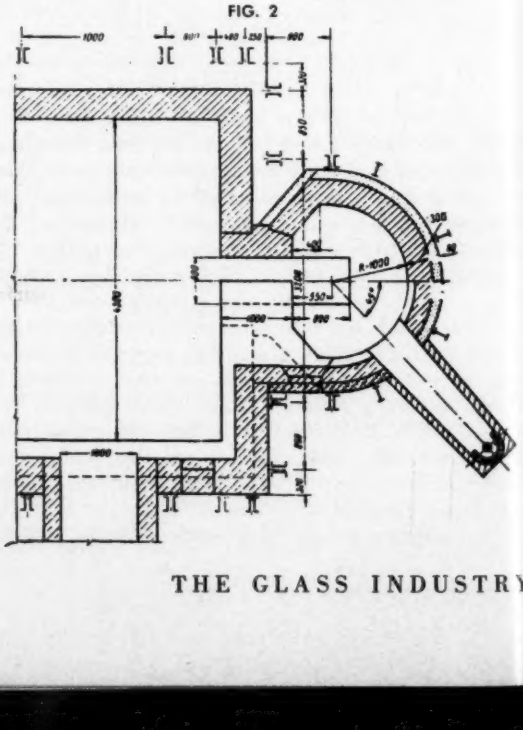
Main experiments have been conducted on two furnaces in two different glass plants.

The furnace of the "Autosteklo" plant is heated with purified producer gas from anthracite, whose heat of combustion is 1215 kg.-cal. per cubic meter at standard temperature and pressure. When goudron spray was introduced and the volume of gas supplied was reduced so as to keep the total amount of fuel (in kg.-cal. per min.) constant, the heat flow toward the glass was greater the greater the degree of substitution of goudron for gas, although at high degrees the effect tended to be constant.

This is shown in Fig. 3. Its abscissa is the amount of goudron (in grams) contained in one cubic meter of

(*Continued on page* 234)

FIG. 2



# ANALYSIS of Brittle Tensile Fracture of Glasses by Ultrasonics

*by Frank Kerkhof* PHYSICAL INSTITUTE OF THE UNIVERSITY OF FREIBERG, GERMANY

*Translated by Thomas H. Elmer, Painted Post, N. Y.*

• BARS CUT FROM SHEET GLASS were broken in axial tension while being irradiated with continuous ultrasonic radiation of 9.1 MHz* frequency. The bars had a cross section of about 9 x 9 mm². They were 14 cm long and had a 2 to 3 mm notch near the middle. The sound irradiation was carried out under water with the sound beam oblique to one of the fire-polished lateral faces.

The angle of incidence for the experiments described here was 23°. It was chosen this wide so as to reflect totally the longitudinal sound waves during transfer of sound from water to glass, and also to allow only the transverse sound waves to penetrate the glass. Fig. 1 is a photograph of such a fracture surface enlarged 8.5 times. The picture was taken with a direct-light-Schlieren-microscope. This fracture surface was permeated during its formation by a continuous, smooth, transverse ultrasound wave whose normal vector pierces the plane of the figure from front position left to back position right. The projection of the normal is shown in the plane of the figure.

The sharp lines which radiate in large number especially from the notched edge are the well-known natural markings known as Wallner lines. These lines have been extensively used by A. Smekal and his co-workers[1] in analyzing crack propagation. On the left edge one can see such lines, some of which can be followed to the lower edge. The softer arcs (lines), which look like waves on a surface of water, and which seem to be nearly concentrically around the break source (marked by a cross), are produced by the artificial sound irradiation. The direction of the propagating crack, which is stipulated by the main tensile stress, is temporarily altered by the ultrasonic waves and the described lines are consequently permanently impressed in the surface of the fracture. Their depth depends on the intensity of the ultrasonic energy (in this case 3 W/cm² in water) and is in the order of 1/1000 mm.

If one assumed that the fracture velocity remains constant the fracture lines (arcs) would be parts of con-focal ellipses. One of their focal points would always coincide with the break origin. The numerical eccentricity of the ellipses would equal the ratio of the fracture velocity and projected velocity of the ultrasonic wave. (Because it is technically more difficult to produce exact axial sonic radiation, circles instead of ellipses would appear which would be identical with the fracture front). The markings due to ultrasonic irradiation show more or less pronounced deviations from the ideal elliptical form. These deviations are a function of fracture velocity and consequently permit one to draw qualitative conclusions about the course of the fracture. Thus, the fracture velocity decreases if the spacing between the sonic lines decreases. With the aid of simple graphic methods, one can reconstruct, quantitatively, the time relationships involved in formation of a fracture front.

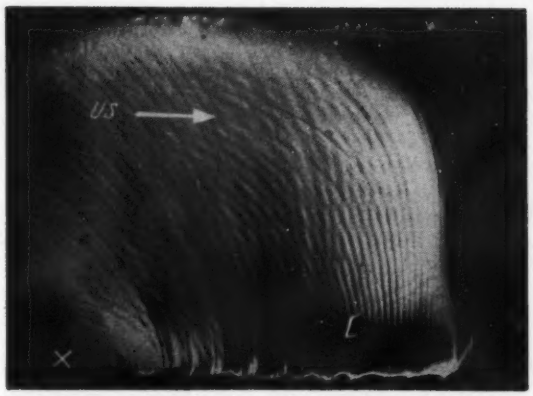



FIG. 1. Fracture surface of a glass rod broken by sonic irradiation with 9.1 MHz (enlarged 8.5 times). The nearly concentric lines around fracture origin (X) were caused by irradiation with ultra sound waves. The arrow, US, gives the projection of the normal line of the ultrasonic wave in the fractured plane.

So as not to disturb the clarity of Fig. 1, the graphic method is not shown. It becomes evident that the maximum fracture velocity of 1450 m/sec. (in this case accurate to only ±5 per cent is reached rapidly after a short starting time in the upper left portion of the fracture surface. This value is in agreement with earlier ones obtained by other methods.[1, 2] In the lower right corner of the figure, at the end of the fracture, the fracture velocity apparently decreases again to less than 500 m/sec. The evaluation of some of the Wallner lines confirms this result.

The new method for studying two dimensional crack propagation opens up the possibility of also obtaining

(*Continued on page* 236)

*MHz = megacycle

This article originally appeared in *Die Naturwissenschaften*, 40, Heft. 18, S. 478 (1953)

# Record 2 to 24 points on the same

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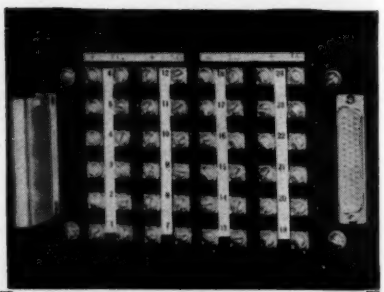
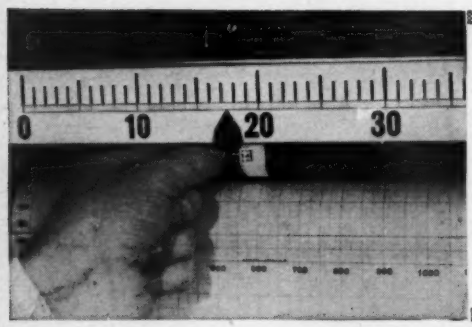
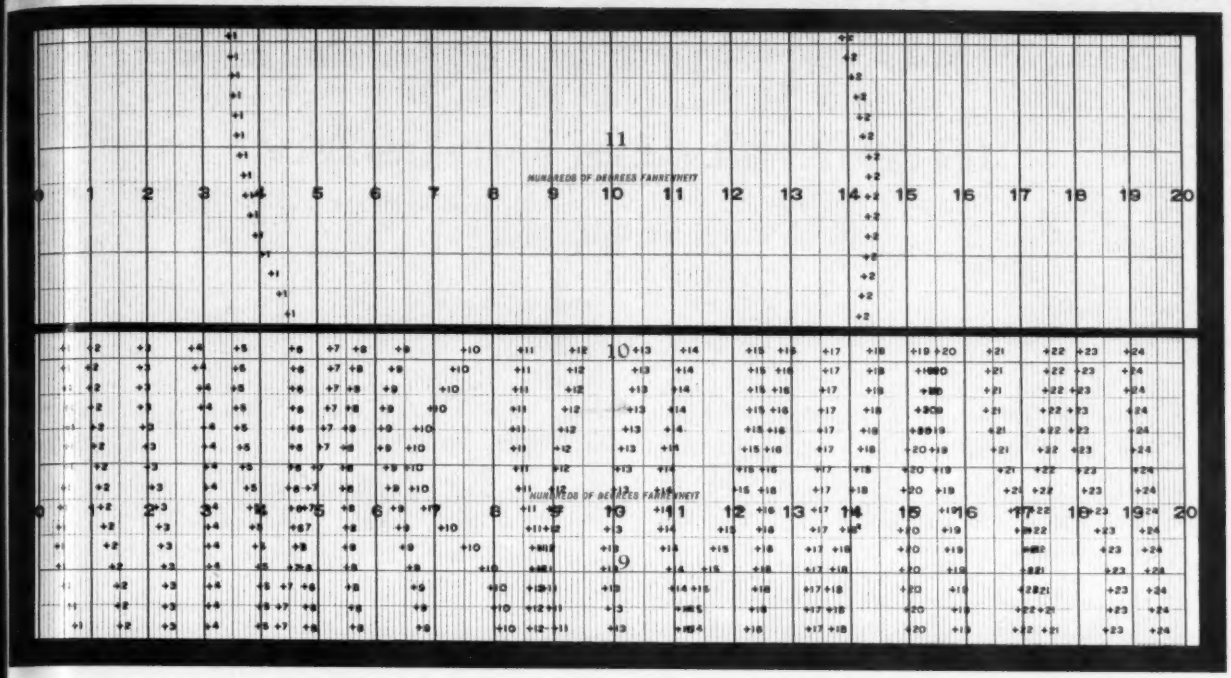





**CHANGING NUMBER OF POINTS IS EASY**—First, remove thumb-tight nut; slip off print wheel and indicator dial. Slip on new wheel and dial and replace nut. Second, replace one plug-in unit on extreme right of terminal board, and the instrument is ready to record any desired number of points.

**CHANGING COMPENSATION IS EASY**—Input terminal board comes out by removing one plug (extreme left) and four screws. Slide in the new board, replace the screws and plug and the compensation is changed. Reference junction is built into terminal board on reverse side.



Now, you can record 2,3,4,6,8,10,12,16,20 or 24 points on one instrument—the new Universal *ElectroniK* Recorder. And you can change the number of points to be recorded in a matter of seconds. It's as easy as this: remove a thumb-tight nut and slip off the old print wheel and indicator dial. Slip on a new wheel and dial and replace the nut. Plug in the number of points wanted, and the job is done.

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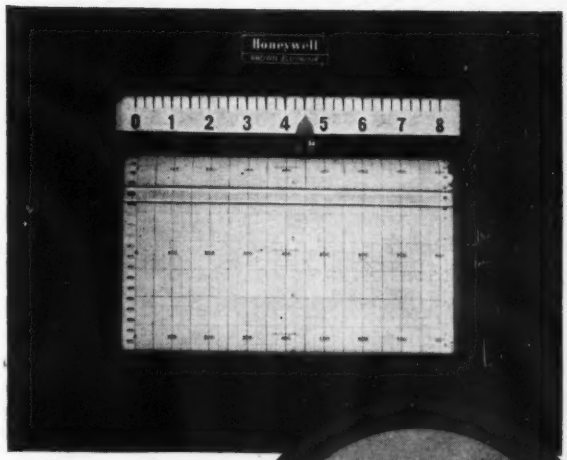


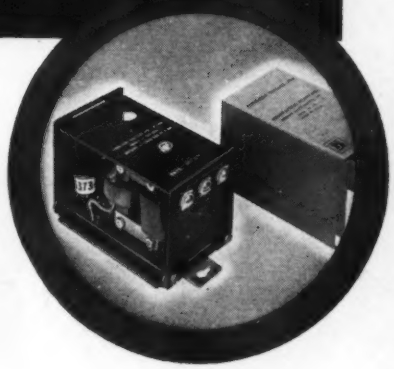

**CONSTANT VOLTAGE UNIT** (Zener diode) eliminates batteries, standard cells, and standardizing mechanisms.

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# NEWS
## IN THE GLASS INDUSTRY

### Personalities...

**John D. Sullivan**

Awarded the 1960 Albert Victor Bleininger Award by the Pittsburgh Section of The American Ceramic Society. The award is "the highest honor conferred in this country for distinguished achievement in the field of ceramics."

Mr. Sullivan is technical director of Battelle Memorial Institute, Columbus, O. Prior to joining Battelle in 1931 he was employed by the U.S. Bureau of Mines. He served as analyst at the Northwest Experiment Station from 1922-23; as assistant physical chemist at the Pacific Experiment Station, 1923-27, and as associate metallurgical chemist at the Southwest Experiment Station, 1927-31.

Becoming a Fellow of the American Ceramic Society in 1939 and an Honorary Member in 1959, Mr. Sullivan served in the interim as Chairman of the Committee on Publications from 1936 to 1942 and again in 1944. He was elected Trustee representing the Refractories Division, 1940-43; and held National Society Offices of Treasurer in 1944-45, Vice President in 1946, and President in 1947. In 1957 he received the First Presidential Award.

**Earl W. Franklin**

Joined the fundamental research group of the General Research Division of Owens-Illinois Glass Company. He will study the reactions of ceramic materials at high temperatures.

**Harry F. Loehrke**

Promoted to manager, Owens-Illinois Glass Company's general research department. He was formerly chief of the department's new development section. Loehrke will be responsible for research and development of materials composed partially of glass and of crystalline substances, and will be in charge of the company's dielectric laboratory.

**William Carpenter**

Assistant to the president of Pittsburgh Plate Glass Company. He was formerly St. Louis district sales manager for the Columbia Southern Chemical Corporation, a wholly-owned subsidiary of Pittsburgh Plate.

**Dr. C. E. Leberknight**

Vice president, research and engineering, for Kopp Glass, Inc. F. A. Frost is vice president in charge of production.

**Albert Lecron**

Elected a director of American-Saint Gobain Corporation. He has been president since 1955 of the French firm, Sovirel, producer of T. V. tubes, optical glass and scientific research tubes.

**James F. Pierson**

Named technical service engineer, glass division, for Pemco Corporation. Having been with the organization since 1949, he started in the research laboratories and transferred to the engineering division in 1952. Pierson will specialize on customer problems in the field of vitrifiable glass colors.

**Eugene W. Fichter**

General manager of manufacturing for the Hazel-Atlas Glass Division of Continental Can Company. He was formerly in charge of West Coast manufacturing operations for Hazel-Atlas glass plants in Oakland and Pomona, Calif. His new headquarters will be in Wheeling, W. Va. Fred J. Heinle will serve as acting head of West Coast manufacturing. He will be plant manager at Oakland and supervisor of the Pimona plant.

Earl W. Franklin

Harry F. Loehrke

Eugene W. Fichter

James F. Pierson

**Stanley H. Maikowski**

General superintendent of manufacturing of the Hartford Division of Emhart Manufacturing Company. He previously served as general foreman and plant superintendent.

**Charles D. Gabor**

Appointed chief engineer for Harbison-Walker Refractories Company, Pittsburgh, Pa. He has been associated with the company since 1941 and served as assistant chief engineer prior to this appointment.

James Lange

Stanley H. Maikowski

Paul V. Ames

Charles D. Gabor

**James K. Lange**

Appointed sales development engineer for The Chas. Taylor Sons Co. He will be with the company's main offices in Cincinnati.

**R. L. Zahour**

Appointed manager of lamp applications for the lamp division of Westinghouse Electric Corporation in Bloomfield, N. J. He will work with lighting fixture manufacturers, consulting engineers and architects on various lighting techniques and developments. He will be responsible for keeping these groups informed of the latest lamp products and for developing new lighting applications using present light sources as well as those presently in the laboratory stage. Zahour will also lecture before technical society groups on these subjects.

**Donald R. Yager**

And Richard Z. Graham have been appointed district manager of Chicago and Kansas City respectively, for Libbey-Owens-Ford Glass Company. J. Robert Drake will replace Graham in Los Angeles as an industrial representative and C. Duane Hostetter, formerly a research analyst, will succeed Drake as assistant to the aircraft product manager.

**Paul V. Ames**

Appointed Eastern sales representative for Vitro Chemical Company, a subsidiary of Vitro Corporation of America.

**Dean L. Browne**

Transferred from the West Chicago, Ill., Lindsay Chemical Division of American Potash & Chemical Corporation to the firm's Los Angeles office.

**Werner A. Frey**

Sales engineer for Corning Glass International, division of Corning Glass Works; will handle European sales of industrial glass products, specializing in radiation shielding windows used in atomic research and development.

**Dr. Wilfred F. L. Place**

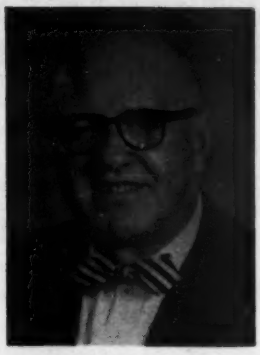
Vice president and general manager for Norton International Inc., Norton's foreign division. Gale W. Bennett is sales manager of refractories. Dr. Place was managing director of Behr-Manning de France for seven years, until 1957, when he became a vice president of Norton International Inc., in charge of Behr-Manning products. He succeeds Frank M. Ryan.

Donald R. Yager

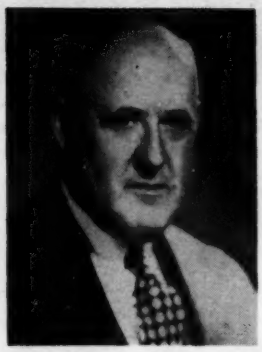
Richard Z. Graham

C. Duane Hostetter

J. Robert Drake



Dr. Woldemar A. Weyl



Kenneth M. Henry

James S. Locke

**Dr. Woldemar A. Weyl**

And Dr. Haskell B. Curry, faculty members at Pennsylvania State University, have been named to the Evan Pugh Research Professorships. Dr. Curry is the Evan Pugh research professor in mathematics and Dr. Weyl, the Evan Pugh research professor in physical science.

Dr. Curry will continue his investigations into the fundamental aspects of mathematical logic, particularly in the special field of combinatory logic.

Dr. Weyl's research in the fields of solid state chemistry and physics has resulted in the publication of more than 100 papers and the granting of 12 patents. He was head of the department of glass research at the Max Planck Institute for Silicate Research from 1926 to 1936 when he became visiting professor of ceramics at Penn State. He accepted the appointment of professor of glass technology in 1938 and later was named head of the division of mineral technology in the College of Mineral Industries.

**Richard S. Grant**

Chief engineer, Eastern Division, for Owens-Corning Fiberglas Corporation. W. R. Steitz is textile products process equipment engineer; J. R. Thumm, general products process equipment engineer; H. O. Youngquist, buildings and utilities engineer; R. P. Witschen, construction engineer; J. D. Knerr, planning engineer; and W. C. Nugent is equipment engineer.

Richard S. Grant

Thomas H. Eaton

**Kenneth M. Henry**

Retired from his position of associate director of research with Owens-Illinois Glass Company, after 40 years.

Mr. Henry began his career in the glass business in California as director of research, and plant manager, for the Illinois Pacific Glass Company, in addition to serving as a director of the company. Later he was vice president and director of American Structural Products Company and Kimble Glass Company. In 1953 he was named assistant director of research for Owens-Illinois and subsequently became the first and only associate director of research. During his career he devised many innovations in technology and production and he now has 25 patents in the glass field.

**James S. Locke**

Newly elected corporate vice president of Minneapolis-Honeywell Regulator Company, became vice president and general manager of Brown Instruments Division of Minneapolis. He will be responsible for operation of the Valve Division in Fort Washington, Pa., and the Fall River, Mass., Division.

**Thomas H. Eaton**

Assistant general manager of the Johns-Manville Fiber Glass Division and vice president of Johns-Manville Fiber Glass Inc. He will assist in the administration of the company's Fiber Glass Division operations at Corona, Calif.; Defiance, O.; Parkersburg, W. Va., and Waterville, O.

## Obituaries...

**William E. Dougherty**

William E. Dougherty, O. Hommel Company, died February 28 at his home after an extended illness. He joined the company in 1920, serving in the color laboratories, becoming head of the pottery frit division. He later traveled as a representative throughout the United States and Canada.

He was a Fellow of the American Ceramic Society and held several offices, the most recent being that of Treasurer.

**John A. Stapp, Jr.**

John A. Stapp, Jr., Chief technical service representative, fluids, for the silicones division of Union Carbide Corporation died at his home in Tonawanda, N.Y., on February 18. His field of interest concerned the use of silicones in the glass industry and he delivered a paper on this subject at the 20th Conference on Glass Problems at the University of Illinois, December 10, 1959.

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**American Scientific Glassblowers Society**

The Metropolitan New York Section held its regular meeting at the Henry Hudson Hotel, New York, on March 18. During a discussion on several high vacuum techniques, Irvin Meyer of Brookhaven National Laboratory showed colored slides of some mercury diffusion pumps, traps, furnaces, McLeod gauges, Toepler pumps and other equipment at the Laboratory. He also gave a talk on the construction and use of a Toepler pump.

Otto Schneider spoke on the construction and use of a McLeod gauge.

During the meeting, the nominating committee presented nominations for the following year:
*Chairman.* Ken Earley, Sylvania Electric; Paul Roman, Brookhaven Laboratories; and Kurt Wurster, Wurster Thermometer Co.
*Vice chairman,* Larry Lorentzen, Burroughs Corp., electronic tube division; Tom Holland, E. H. Sargent; and Irvin Meyer, Brookhaven Laboratory.
*Secretary.* Ralph Abrahammer, Fisher Scientific Company; and Otto Schneider, Brookhaven.
*Treasurer.* Edward Deery, Heights Laboratory Glass; George Fuchs; and Larry Alexander.

Mr. Deery was also nominated as regional director, and Chester Lewis, Texaco Research, as an alternate.

# Companies...

**Armstrong Cork Co.**

Rebuilding and enlarging one of five glass melting furnaces at the Millville, N. J., glass container plant to increase production capacity by 35 per cent.

The Millville plant produces containers for food, beer and carbonated beverages, drugs and pharmaceuticals, toiletries and cosmetics, wine and liquor, and chemical, household and industrial products.

**Corning Glass Works**

Produced the largest fused silica mirror ever made to serve as the primary reflective piece in a 36-inch telescope that will be carried aloft by an unmanned balloon for outer space photography. The 450-pound blank is 37 inches in diameter and 5½ inches thick. It will be installed in the telescopic system of Project Stratoscope II, which is being conducted by Princeton University with funds from the National Science Foundation, the Office of Naval Research, and the National Aeronautics and Space Administration. The balloon flight is scheduled for sometime in 1961. The project is the forerunner to proposed satellite observatories and follows the successful balloon flights under Project Stratoscope I in which a 12-inch telescope provided the clearest pictures yet taken of the sun.

The larger telescope is expected to provide information, via photographs, on the atmosphere of Jupiter and Venus, permit analysis of the division of Saturn's rings, and provide a means of measuring the diameter of Pluto. The project may shed further light on the Great Nebula in Orion where new stars apparently are forming in dense interstellar clouds.

Fused silica was specified for the mirror because of its near-zero thermal expansion. Corning formed the material by a special technique which is said to be one of the purest man-made substances. Impurities average less than one part per million.

**Bausch & Lomb Optical Co.**

Stockholders recently voted at a special meeting to change the company name to Bausch & Lomb, Inc.

**United States Borax & Chemical Corp.**

Moved to larger quarters at 1627 Peachtree St., N. E., Atlanta 9, Ga. The move follows a recent reorganization which combined the sales forces of the company's former Pacific Coast Borax and United States Potash Divisions into one marketing department.

**Food Machinery and Chemical Corp.**

Dropped the name *Westvaco* from the Divisional and brand identifications on April 1. Former Westvaco Divisions are now called the Chlor-Alkali and Mineral Products Divisions of the Corporation.

Largest fused silica mirror blank ever produced, shown here before grinding and polishing. Corning Glass Works produced the blank for Project Stratoscope II. It will serve as the primary reflective piece in a 36-in. telescope, to be carried aloft by an unmanned balloon for outer space photography.

**Drakenfeld & Co.**

Expanding its factory and research center in Washington, Pa. The 22,000 sq. ft addition is scheduled for completion this spring.

**Ferro Corp.**

Purchased the Vitro Manufacturing Company division of Vitro Corporation of America for approximately $500 million.

Ferro Corporation produces porcelain enamel frit, and Vitro Manufacturing Company manufactures glass and overglaze colors, glaze stains, and porcelain enamel oxides.

Said Frank B. Jewett, Jr., president of Vitro Corporation of America, "As Vitro Corporation has developed in nuclear, chemical, and engineering areas, it has grown further away from the ceramic color business of the Vitro Manufacturing Company from which Vitro Corporation derived its name. The loss of compatibility with present and future business of the Corporation made it desirable to sell Vitro Manufacturing Company to an organization with related ceramic activities."

Ferro has been establishing glass color operations in several of their foreign subsidiaries for more than a year. They are manufacturing and marketing glass colors in Brazil, Mexico, Argentina, Australia and Canada and will set up operations this year at their plants in Holland and England.

According to Harry T. Marks, president of Ferro Corporation, "The availability of the plant and business of the Vitro Manufacturing Company division of Vitro Corporation has provided us with an excellent opportunity to enter this market in the United States and make use of the considerable technical knowledge we have gained through our manufacture of these materials abroad."

Transfer of the plant and assets of the Vitro Manufacturing Company took place on March 1.

Steven Heller, assistant sales manger, Glascote Products, Inc., presents Clarence W. Nielsen, Research Engineer, Dow Chemical Company, with a Steuben glass compote. The compote was given as a prize in a drawing held to commemorate the introduction of new Glascote glass —778—at the Exposition of the Chemical Industries Show in New York City.

Architect's drawing of Food Machinery and Chemical Corporation's new Chemical Research and Development Center, Princeton, N.J. Research functions include polymer applications, functional fluids and work of a general analytical nature which is related to the company's five chemical divisions.

**Food Machinery and Chemical Corp.**

Completed its Chemical Research & Development Center at Princeton, N.J., bringing to three the number of chemical research facilities.

**American Optical Co.**

In conjunction with Pyrotector Inc., of Hingham, Mass., is utilizing the glass threads of fiber optics in a new aircraft fire detection device.

In the new instrument a bundle of optical fibers runs from the aircraft engine compartment to an electronic signal-activating unit. Light from the engine fire of another aircraft is seen through the bundle by the electronic sensing device, which activates an audible signal and a warning light on the instrument panel. The sounding of the signal warns the pilot of the other aircraft and indicates its position.

**Glascote Products, Inc.**

Announced broad expansion plans designed to double present production facilities. The expansion is being initiated to enable the company to provide larger units for the chemical reactor field.

L. T. Hickey, vice president and general manager stated that there is a distinct trend under way today toward utilizing larger reactors. "Three years ago our most popular reactor was 1,000 gallons in capacity. Today, the 3,000-gallon heavy-duty glass-lined reactor is most in demand. Tomorrow, we anticipate that calls for 5,000-gallon, heavy-duty glass-lined reactors will be commonplace."

## FINANCIAL DATA

**American Potash & Chemical Corp.**

| | *1959* | *1958* |
|---|---|---|
| Net earnings | $ 5,149,755 | $ 4,370,443 |
| Net sales | $ 54,621,189 | $ 47,920,105 |

**American-Saint Gobain Corp.**

| | *1959* | *1958* |
|---|---|---|
| Net earnings | $ 802,977 | $ 319,732 |
| Net sales | $ 32,496,896 | $ 24,764,897 |

**Pittsburgh Plate Glass Co.**

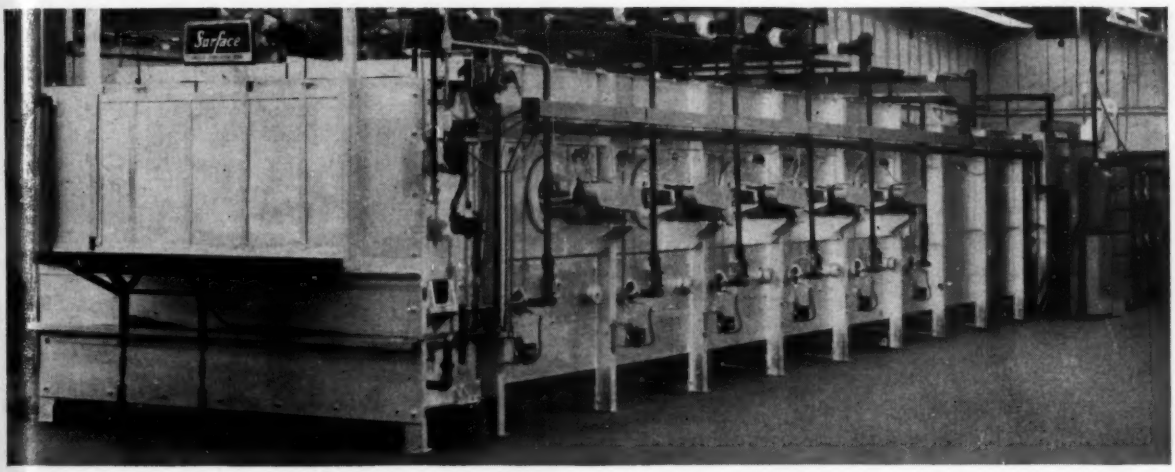
| | *1959* | *1958* |
|---|---|---|
| Net earnings | $ 44,096,000 | $ 32,076,000 |
| Net sales | $606,947,000 | $513,649,000 |

# duplicate cycles with precision in modular lehr

The Surface modular lehr offers a final solution to the company which wants to replace obsolete equipment, but dreads the excessive engineering costs of new units.

This lehr is really a series of standardized modules, which can be linked together to reproduce any prescribed temperature curve. This type of design saves you money because it spreads the engineering costs over many modules, and makes assembly fast and economical.

This lehr has many other features. In many cases, it makes replacement more profitable than retaining outmoded equipment. Please let us tell you more about it.




*The new Surface modular lehr, annealing television tubes.*

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A Division of Midland-Ross Corporation · *In Canada: Surface Industrial Furnaces, Ltd., Toronto, Ontario*

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Surface

# INVENTIONS AND INVENTORS

## Annealing and Tempering

*Glass Bending Molds. Patent No. 2,903,825.* Filed November 7, 1956. Issued September 15, 1959. No sheets of drawings; none reproduced. Assigned to Pittsburgh Plate Glass Company by Ronald E. Richardson.

The present invention is concerned with the construction of molds for the preliminary bending of one or more sheets of glass during passage through a furnace.

It has become the practice to form molds for this purpose with pivoted end portions each of which either can be swung into a first position (when the flat, cold glass is originally placed in position thereon—subsequently referred to as the "flat" position of the mold), or can move into a second position (the "curved" position of the mold) as the resistance to bending of the glass decreases on exposure to higher temperatures. Weights tending to urge the movable portions of the mold into such latter position are normally provided.

The present invention provides a device mounted adjacent to a pivoted end mold portion for improving the bending operation, such device comprising a body of metal of thermal capacity large in relation to the neighboring mold parts, the body being mounted on the main mold portion so as to be positioned outwardly of the perimeter of the movable end mold portion and, in the "flat" orientation of the mold, adjacent the end portion.

There were 8 claims and the following references cited in this patent.

### United States Patents

2,240,349, Preston, Apr. 29, 1941; 2,452,488, Paddock et al. Oct. 26, 1948; 2,695,476, Jendrisak, Nov. 30, 1954; 2,744,359, Jendrisak, May 8, 1956.

### Foreign Patents

1,076,391, France, Apr. 21, 1954; 710,393, Great Britain, June 9, 1954; 727,200, Great Britain, Mar. 30, 1955.

## Feeding and Forming

*Apparatus for forming fused glass articles. Patent No. 2,881,563.* Filed December 27, 1957. Issued April 14, 1959. No sheets of drawings; none reproduced. Assigned to American Optical Company by Lee O. Upton and Ernest T. Dalton.

This invention relates to fused glass articles and has particular reference to improvements in apparatus for heat treating and heat-joining the surfaces of such articles.

Lens blanks preferably formed of optical crown glass, having a ground and polished countersink of controlled curvature to which a segment part or disc of flint, barium or other suitable high index optical glass is fused form the completed optical pecticule.

A device is shown which is designed to successively receive, heat treat, assemble fuse, and anneal the major and minor parts of a plurality of lens blanks of the character described above.

The apparatus is adapted to perform the steps of dehydrating and oxidizing the surfaces of pieces of glass to be fused to prevent the formation of interfacial bubbles during fusing, temperature-conditioning each of said pieces prior to their assembly to prevent thermal shock or an undesirable glass wetting of one of said pieces by another thereof at the time of their initial contact with each other, maintaining the surfaces of said pieces to be joined substantially free of foreign matter during said dehydration and temperature-conditioning, assembling said pieces in accurate register with each other, causing said pieces to fuse together and thereafter annealing the fused article.

There were 10 claims and the following references cited in this patent.

### United States Patents

1,638,452, Panajiotaros et al., Aug. 9, 1927; 2,026,606, Bausch, Jan. 7, 1936; 2,433,013, Ziegler, Dec. 23, 1947; 2,691,246, Roeber, Oct. 12, 1954.

*Apparatus for Feeding and Conveying Molten Glass. Patent No. 2,910,806.* Filed September 9, 1954. Issued November 3, 1959. No sheets of drawings; none reproduced. Assigned to Owens-Corning Fiberglas Corporation by Robert G. Russell and David Denelsbeck.

This invention relates to apparatus for processing glass and more patricularly to an apparatus for conditioning and processing glass to form fine fibers or filaments therefrom.

The invention involves the use of a comparatively large melting furnace or tank furnace of a type similar to furnaces now utilized in the glass industry for molding bottles or other articles wherein large quantities of molten glass are required in carrying on commercial molding operations. In the present invention the heat-softenable material in flowable form is conveyed by one or more forehearths to a distributing station or stations at which the heat-softened material is delivered as individual gobs or bodies to units of a group in sequential order from which units the material is continuously discharged and attenuated to filaments or fibers.

There were 2 claims and 17 references cited in this patent.

*Glassware Transfer Mechanism. Patent No. 2,904,161.*

Filed December 10, 1956. Issued September 15, 1959. No sheets of drawings; none reproduced. Assigned to Owens-Illinois Glass Company by Carl W. Schreiber.

This invention provides a means for maintaining a spaced relationship between the trailing transfer arm and the delivered ware being carried on the conveyor regardless of conveyor speeds or ware spacings. In this manner, the conveyor speed may be decreased over the speed heretofore required and will thereby permit ware to be more closely spaced and retained on the conveyor a longer period of time. This closer spacing and increased time of traveling permits a better and more efficient cooling of the ware before delivery to the next operation which is so often essential to the production of good quality glass ware.

Furthermore, conveyor speed may be decreased to accommodate more readily some subsequent transfer operation to another step in carrying out the manufacturing process being performed, such as transfer to a burn-off machine.

There were 12 claims and the following references cited in this patent.

### United States Patents

1,245,730, Johnson et al., Nov. 6, 1917; 2,112,119, Rowe, Mar. 22, 1938.

### Foreign Patents

316,064, Germany, Nov. 20, 1919.

*Lamp Fabrication. Patent No. 2,896,306.* Filed June 30, 1953. Issued July 28, 1959. No sheets of drawings; none reproduced. Assigned to Westinghouse Electric Corporation by Herman James Eberiel and Frederick Theodore May.

The invention provides a method of attaching the protruding side wire to the base shell of an otherwise substantially fabricated lamp. The method comprises positioning the wire at a predetermined angle away from the lamp bulb and toward the base shell, tensioning the wire while so positioned, and ripping a crevice with the tensioned wire in the peripheral edge of the base shell. The side wire is then wedged in the crevice to retain same in permanent electrical contact with the material of the base shell, and the excess portion of the wire adjacent the crevice and the base shell is severed.

There were 2 claims and the following references cited in this patent.

### United States Patents

2,069,386, Palucki, Feb. 2, 1937; 2,077,199, Asmussen, Apr. 13, 1937; 2,327,033, Flaws, Aug. 17, 1943; 2,342,041, De Bold, Feb. 14, 1944; 2,390,139, Vasseli, Dec. 4, 1945; 2,403,137, Strickland, July 2, 1946; 2,667,189, Flaws, Jan. 26, 1954; 2,711,791, Bechard et al., June 28, 1955.

## Furnaces

*Glass Melting Furnace With Bubbler Patterns. Patent No. 2,909,005.* Filed November 13, 1956. Issued October 20, 1959. No sheets of drawings; none reproduced. Assigned to Owens-Illinois Glass Company by Basil D. Beck, Sr. and Arthur B. Swain.

This invention relates to the efficient utilization of bubblers in a glass furnace, and more patricularly to the patterns of arrangement of these bubblers and means for providing patterns of convection currents in the melting zone of a glass melting furnace to increase the efficiency and output of production of the furnace.

The various patterns of bubbler arrangements involve a first array of bubblers spaced substantially equal distances from the withdrawal throat and in addition thereto more than one (at least two) spaced rows of bubblers to comprise any given configuration or size of geometric patterns in the second array of bubblers.

The following specific improved results in the melter are derived from such patterned arrangement of the bubblers:

1. a more uniform homogeneity of the glass is produced, 2. certain types of stones such as nepheline and batch, are minimized, 3. the temperature gradient in the glass body between the floor of the melter and the glass surface is decreased, thereby promoting increased melter efficiency, 4. an increase in temperature of the glass in the refiner is obtained by increasing the temperature of the glass near the bottom of the melter, 5. any color or density separation is prevented from occurring in the melter in the production of colored glasses, such as emerald green and champagne green glasses, 6. an increase in the loads is obtained in melting the aforementioned colored glasses, 7. batch color streak or cord is eliminated in the production of lead-barium glass and borosilicate glass.

There were 12 claims and the following references cited in this patent.

### United States Patents

2,331,052, Shadduck, October 5, 1943; 2,387,222, Wright, October 16, 1945.

*Electrode for a Glass Melting Furnace. Patent No. 2,908,738.* Filed December 21, 1956. Issued October 13, 1959. No sheets of drawings; none reproduced. Assigned to Owens-Illinois Glass Company by Robert R. Rough.

This invention relates to an improved electrode construction suitable for use in the electric melting of glassy materials. The electrode is preferably fabricated from molybdenum, although it is understood that such materials as graphite, tungsten, or other similar materials, which, in addition to exhibiting the requisite electrically conductive properties, do not materially affect the composition or color of the resultant glass, are also suitable.

Slidably journalled through the bushing there is an elongated conduit which extends coaxially into the hollow central portion, or cooling chamber of the electrode. This conduit is connected at its outer end through a flexible coupling to a suitable coolant supply. In such position, the conduit which is substantially smaller than the cooling chamber, cooperates with the interior surface of the electrode to define an annular coolant passage, which communicates with a discharge outlet, extending through the bushing to permit coolant, after being circulated through the cooling chamber and coolant passage, to be discharged into a drain.

There is presented an improved construction which permits the electrode to be effectively protected from excessive thermal oxidation and decomposition without the necessity of employing expensive and burdensome cooling jackets, oxidation shields, and the like, surrounding or encasing the electrode.

Another advantage of an electrode construction having a cooling chamber formed internally of the electrode itself resides in the fact that although the amount of material such as molybdenum from which the electrode is fabricated is substantially reduced, the electrical heating effectiveness remains practically the same as would be obtained from an electrode of solid construction, assuming identical diametrical dimensions.

There were 5 claims and the following references cited in this patent.

**United States Patents**

858,400, Von Kugelgen et al., Jan. 31, 1905; 2,693,498, Penberthy, Nov. 2, 1954.

## Glass Compositions

*Method of incorporating titanium into selectively transparent silica glass. Patent No. 2,895,839.* Filed May 14, 1955. Issued July 21, 1959. No sheets of drawings; none reproduced. Assigned to Quartz & Silice S. A., by Henri J. C. George.

This invention provides a selectively transparent silica glass by heating to about 1750° C. and then cooling a mixture consisting of substantially pure silicon dioxide and titanium oxide in an amount effective to render the glass substantially opaque to light radiation of 1850 A.U. while being transparent to radiation of 2537 A.U. The method of incorporating the titanium into the silicon dioxide prior to heating comprising mixing an aqueous solution of a water-soluble titanium salt with a mass of silica particles in an amount to substantially fill the voids between said particles, adding a base to said mixture effective to precipitate titanium hydroxide, removing the by-products from said precipitation, and drying the mixture.

There were 2 claims and the following references cited in this patent.

**United States Patents**

2,049,359, Dusing et al., July 28, 1936; 2,326,059, Nordberg, Aug. 3, 1943; 2,757,305, Duziergwa, July 31, 1956.

*Glass composition. Patent No. 2,883,296.* Filed November 23, 1953. Issued April 21, 1959. No sheets of drawings; none reproduced. Assigned to L. O. F. Glass Fibers Company by Dominick Labino.

This invention relates to a glass composition which is particularly useful in the production of glass fibers and which glass has characteristics which render it very suitable for electrical insulation as well as plastic reinforcement purposes.

It is a principal object of this invention to describe a glass composition which gives up its gaseous constituents readily and accordingly does not foam or re-boil in the melting pot as is usual with many fiberizing glasses.

A glass composition is provided which has characteristics such that it becomes possible to operate a glass melting pot for the production of fibers at a lower temperature than is customarily employed which results not only in the saving of fuel and equipment costs but permits the use of larger nipple openings in the pot due to the greater glass viscosity at the lower temperature; the viscosity is closely controllable and larger fibers of great length may be formed without danger of excessive filament breakage.

Such a composition comprises basically the following ingredients in weight per cent:

| | |
|---|---|
| $SiO_2$ | 62-68 |
| $B_2O_3$ | 8-12 |
| CaO | 7-14 |
| Alkali ($Na_2O$ and $K_2O$) | 3- 8 |
| $Al_2O_3$ | 3- 7 |

There were 4 claims and the following references cited in this patent.

**United States Patents**

1,365,797, Smith, Jan. 18, 1921; 2,308,857, Bowes, Jan. 19, 1943; 2,457,777, Holtschulte et al., Dec. 28, 1948.

**Foreign Patent**

512,875, Great Britain, Sept. 27, 1939.

*Glass compositions. Patent No. 2,838,408.* Filed January 28, 1955. Issued June 10, 1958. No sheets of drawings; none reproduced. Assigned to Prismo Safety Corporation by Guy E. Rindone.

The present invention relates to glass compositions having a high index of refraction and, more particularly, to glass compositions suitable for making glass beads for use as retroreflective elements.

A glass is provided having an index of refraction of at least 1.90, which is chemically stable to weathering, and contains silicon dioxide, titanium dioxide, and at least two of the following ingredients: barium oxide, lead oxide, alkali metal oxide, such as potassium, sodium or lithium oxide, and arsenic oxide.

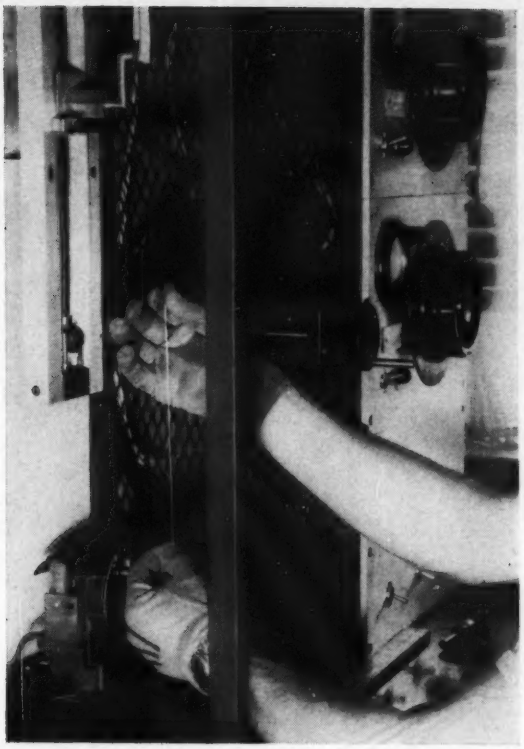
On slow cooling these glass compositions devitrify completely. However, rapid quenching prevents devitrification and produces transparent particles. Quenching the molten glass in water, as is the usual practice, is sufficient to produce transparent glass particles. Liquid droplets formed by passing crushed and graded particles of the glass through a flame or a radiant-heat stack, may be quenched to provide spherical transparent beads.

A glass which has given exceptionally good results in the form of small glass beads, when used as retroreflective lenses, has the following composition:

| | Mol Per cent | Wt. Per cent |
|---|---|---|
| $SiO_2$ | 33.0 | 19.2 |
| $TiO_2$ | 34.0 | 26.4 |
| BaO | 25.1 | 37.4 |
| PbO | 7.5 | 16.2 |
| $AS_2O_3$ | 0.4 | 0.8 |

There were 11 claims and the following references cited in this patent.

(*Continued on page* 238)



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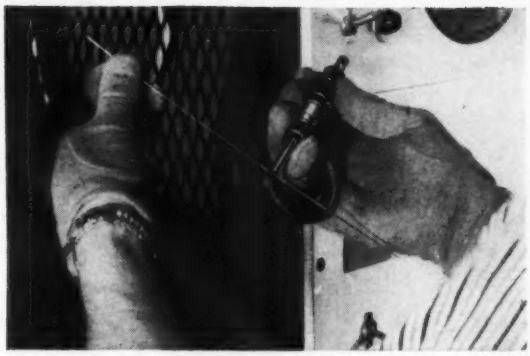

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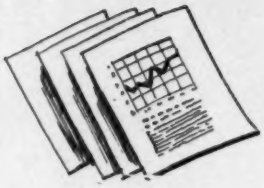

# RESEARCH DIGEST

## Surface Hardness of Sheet Glass Untreated and Treated with Vapours of Metal Chlorides

● THE PROPERTIES OF THE SURFACE layers of alkali-lime-silica glasses differ from those of the bulk of the glass. The differences are of practical significance and of theoretical interest. By measuring the indentation hardness of surfaces of drawn sheet glass G. Koranyi, Journal of the Society of Glass Technology, December 1959, has found that the surface structure of the outer layer of 0.5-0.6 is less dense than that of the deeper regions.

By using a steel ball instead of a diamond pyramid with uniformly increasing load, the so-called fracture hardness of glass can be determined, but the magnitude of the force required for fracture is influenced largely by the dimensions of the ball. In indentation hardness tests carried out with Vickers-type diamond pyramids the elastic deformations due to the elasticity of the glass taking place after the removal of the penetrating body were not taken into account but later correction factors were introduced for the elimination of this source of error.

Frequently the indentation hardness is taken as the hardness of the glass instead of a guide to the hardness relations of the glass surface. The surface plays an important part in indentation hardness tests and the surface hardness does not correspond with the inner hardness of the glass material. In some cases there is a relationship between the indentation hardness and the chemical composition of the glass.

It can be shown that a false result is obtained by using a diamond pyramid or double pyramid to measure the static or plastic hardness of the glass owing to the considerable concentration of forces arising in the indentation at the edges and apex of the pyramid. Instead, the use of a diamond cone or spherical surface with clear force relations was proposed. By measuring the indentation hardness with a testing body of spherical surface the plastic hardness of the glass surface is actually determined, because the pressure of the rounded-off apex of the diamond cone produces a plastic flow of the glass surface at room temperature. The indenting surface of the Rockwell-type diamond cone is a spherical segment with a radius curvature of 200$\mu$. By taking advantage of the transparency of the glass, an instrument equipped with a Rockwell-type diamond cone was constructed for the microhardness determinations which was suitable for the investigation of the hardness relations of the glass layer extending from the surface to a depth of 0.1 to 1.5$\mu$.

It seemed practical to support the theoretically correct determinations of surface hardness by numerical data, giving thus as a measure of the relative hardness of glass surfaces the load in grams causing an indentation of unit value (e. g. 0.01$\mu$).

The effect of metal chloride vapours on the properties of glass surfaces can be studied by the following procedure.

a. Determination of the hardness properties of the untreated surface.
b. treatment of the glass surface with metal chloride vapours at a given temperature for a given time.
c. investigation of the layer produced on the surface.
d. determination of the modified hardness properties of the treated glass surface.

Measurements (a) and (d) were carried out using a microindentation hardness testing instrument allowing direct observation. The instrument consists of the following parts:

1. Optical system with upper illumination suitable for use with a polarization filter.
2. Stage with clamps and sample holding slide.
3. Scale beam with a dish for the weights at one end and with an upward directed Rockwell-type diamond cone at the other.
4. Arresting device of the scale beam.
5. Common frame for the scale beam and the stage.
6. Micrometer ocular.

The experiments provide information on the effects of metal chlorides on glass surfaces and an opportunity to draw conclusions about the surface structure of alkali-lime-silica glasses and the modification of this structure.

It is well known from the literature and supported by experimental facts that the glass surface is covered by a layer of $SiO_2$ gel which does not contain sodium ions at all or has—in deeper layers—a decreased sodium ion content. Close to room temperature the $Na^+$ ions are replaced by $H^+$ or $H_3O^+$ ions (hydrogen glass) and in

(*Continued on page* 235)

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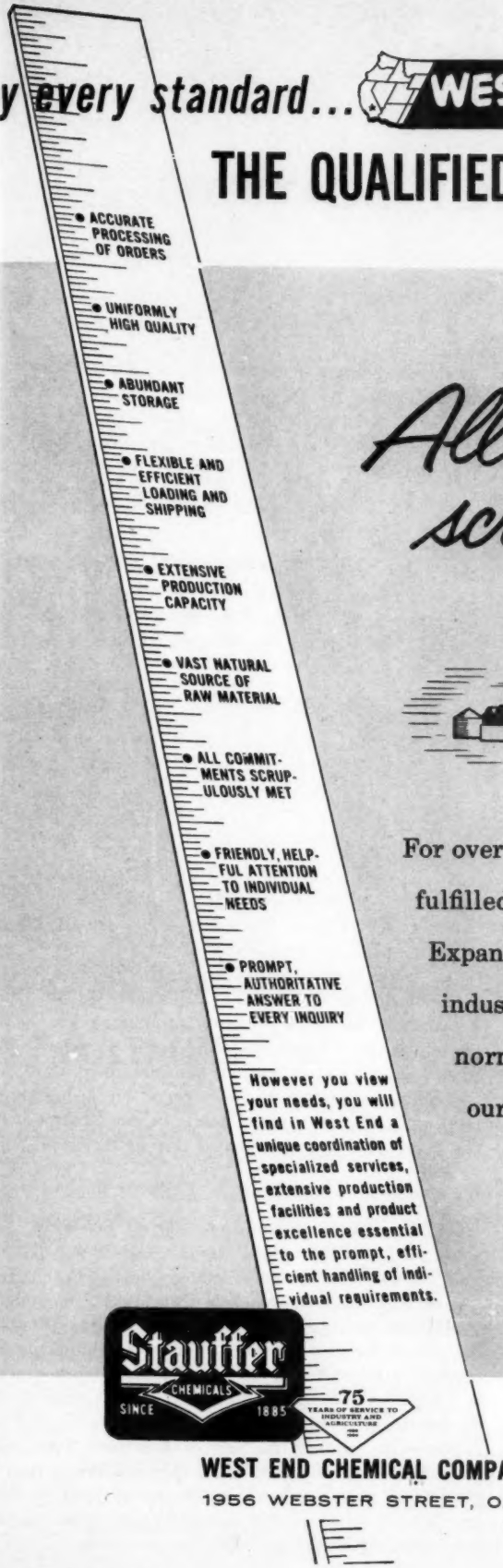
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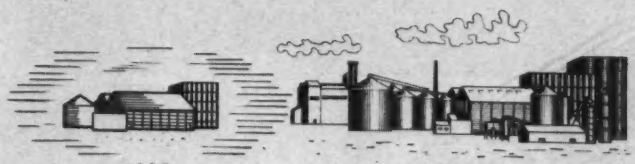

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# CURRENT STATISTICAL POSITION OF GLASS

**Employment** in the glass industry during January, 1960, was as follows: *Flat Glass*: a preliminary figure of 32,000 for January, 1960 indicates a decrease of 0.9 per cent under the adjusted figure of 32,300 reported for December, 1959. *Glass and Glassware, Pressed and Blown*: a decrease of 1.1 per cent is shown by the preliminary figure of 84,900 reported for January, 1960, when compared with the adjusted figure of 85,900 reported for December, 1959. *Glass Products Made of Purchased Glass*: the preliminary figure of 14,500 given for January, 1960, is 2.0 per cent under the adjusted figure of 14,800 reported for December, 1959.

### GLASS CONTAINER SHIPMENTS

(All Figures in Gross)

**Narrow Neck Containers**

| | February, 1960 |
|---|---|
| Food | 1,190,000 |
| Medicinal and Health Supplies | 1,297,000 |
| Chemical, Household and Industrial | 891,000 |
| Toiletries and Cosmetics | 881,000 |
| Beverage, Returnable | 501,000 |
| Beverage, Non-returnable | 79,000 |
| Beer, Returnable | 159,000 |
| Beer, Non-returnable | 679,000 |
| Liquor | 689,000 |
| Wine | 425,000 |
| Sub-total (Narrow) | 6,791,000 |

**Wide Mouth Containers**

| | |
|---|---|
| Food | *3,329,000 |
| Medicinal and Health Supplies | 457,000 |
| Chemical Household and Industrial | 255,000 |
| Toiletries and Cosmetics | 261,000 |
| Dairy Products | 123,000 |
| Sub-total (Wide) | *4,425,000 |
| Total Domestic | 11,216,000 |
| Export Shipments | 244,000 |
| TOTAL SHIPMENTS | *11,460,000 |

* This figure includes Fruit Jars, Jelly Glasses, and Packers' Tumblers.

### GLASS CONTAINER PRODUCTION AND INVENTORY

(All Figures in Gross)

| | | Production February 1960 | Stocks February 1960 |
|---|---|---|---|
| Food, Medicinal and Health Supplies; Chemical, Household and Industrial; Toiletries and Cosmetics | Narrow Neck | 4,792,000 | 7,059,000 |
| | Wide Mouth | *4,840,000 | *6,434,000 |
| Beverage, Returnable | | 889,000 | 2,294,000 |
| Beverage, Non-returnable | | 87,000 | 266,000 |
| Beer, Returnable | | 342,000 | 558,000 |
| Beer, Non-returnable | | 877,000 | 1,059,000 |
| Liquor | | 704,000 | 1,606,000 |
| Wine | | 452,000 | 811,000 |
| Dairy Products | | 148,000 | 336,000 |
| TOTAL | | *13,131,000 | *20,423,000 |

* This figure includes Fruit Jars, Jelly Glasses, and Packers' Tumblers.

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**Payrolls** in the glass industry during January, 1960, were as follows: *Flat Glass*: a decrease of 3.0 per cent is shown in the preliminary $17,291,789.76 given for January, 1960, when compared with December's $17,828,982.10. *Glass and Glassware, Pressed and Blown*: a decrease of 0.5 per cent is shown in the preliminary $32,924,517.15 reported for January, 1960, when compared with the previous month's adjusted $33,100,163.97. *Glass Products Made of Purchased Glass*: a preliminary figure of $4,817,471.84 was reported for January, 1960. This is a decrease of 0.02 per cent when compared with the adjusted figure of $4,818,607.98 for December, 1959.

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**Glass Container Production** based on figures released by the Bureau of the Census, Industry Division, was 13,131,000 gross during February, 1960. This is an increase of 2.9 per cent over the previous month's production figure (revised), 12,755,000 gross. During February, 1959, glass container production was 11,416,000 gross, or 13 per cent under the February, 1960, figure. At the end of the first two months of 1960, glass container manufacturers have produced a preliminary total of 25,886,000 gross. This is 11 per cent more than the 22,920,000 gross produced during the same period in 1959.

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**Glass Container Shipments** during February, 1960, came to 11,460,000 gross, an increase of 2.3 per cent over January, 1960, which totaled (revised) 11,197,000 gross. Shipments during February, 1959, amounted to 10,510,000 or 8.2 per cent less than February, 1960. At the end of the first two months of 1960, shipments have reached a preliminary total of 22,657,000 gross, which is 4.3 per cent more than the 11,197,000 gross shipped during the same period the previous year.

Stocks on hand at the end of February, 1960, came to 20,423,000 gross. This is 6.7 per cent more than the 19,123,000 gross on hand at the end of January, 1960, and 7.2 per cent less than the 18,938,000 gross on hand at the end of February, 1959.

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New Porter M-90+ and M-90+B chemically bonded and burned basic brick are a 95 per cent *plus* pure magnesia (MgO) . . . the *purest* brick for glass furnace checkers.

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The greater weight, density and strength of Porter basic checker construction mean:

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b. lower chemical reaction
c. less distorting growth from batch carry-over
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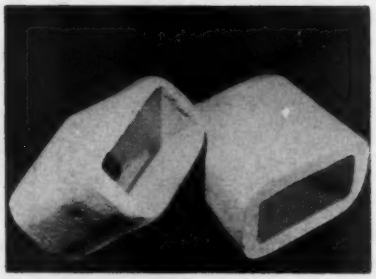

### Insulation Material

Fibrous potassium titanate insulation material in complex integral shapes which exhibits very low thermal conductivity at temperatures up to 2200°F. Shapes include: rectangular and curved pads and solids, flat and arched; uniform rectangular pipe; uniform circular pipe and; discs and bowl shapes.

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Electrically conductive transparent coatings by vacuum deposition of certain materials. Properties of the coatings include 75 per cent transmission of visible light, resistance of 15 ohms per square inch, and stability over long periods of time at temperatures between −50°F and +200°F. The coatings have been applied to glass and plastics.

**National Research Corp., Cambridge, Mass.**

### Fiberglass Outerwrap

An outerwrap for the protection of underground pipe lines. The bitumen-saturated Fiberglas is said to be resistant to impact and soil stress and not affected by acids and fungus. It is designed to cover both hot and cold wrapping applications and will not attack the protective enamel or wick-out the oils of the saturants. Standard widths are: 2″, 3″, 4″, 6″, 9″, 12″ and 18″. Standard lengths are: 400 ft., 800 ft., and 1,000 ft.

**Owens-Corning Fiberglas Corp., 717 Fifth Ave., New York City**

### Radiant Heater

An industrial radiant heater engineered for quick warm-up and cool-off, reaches full heating capacity of 800 to 850°F within three minutes. It produces an average of 20 watts per sq. in. of working surface and is designed for horizontal mounting above or below the process line. The heater uses 96 per cent silica glass in tube form. It has a triple reflector system which directs 85 to 90 per cent of the available radiation onto the work. Fire-bonded to one side of the tube is a strip of non-tarnishing platinum that forces the heat toward the product. It is framed in aluminized steel, and comes equipped with junction box and leads.

**Corning Glass Works, Corning, N. Y.**

### Electric Vibrator

A totally enclosed explosion-proof electric vibrator is approved by Underwriters' Laboratory for use in Class I, Group D conditions which include atmospheres containing natural gas, gasoline, naptha and similar vapors. The units contain no pulleys, belts or springs and delivers 3,600 vibrations per minute with 60 cycle current. Vibration force is produced by eccentric weights which are fastened on each end of the rotating motor shaft. Vibration impact is adjustable from 385 to 1,100 lbs. in seven separate settings. It is 9 inches long, 8½ inches wide and 6 inches high.

**Cleveland Vibrator Co., 2828 Clinton Ave., West, Cleveland 13, O.**

### Battery Powered Lifter

A compact battery powered portable lifter enabling operator to lift, transport and position loads weighing up to 1000 lbs. A 26″ x 28″ platform is lifted from 4½″ above the floor to 64″ at 20 Fpm by a unitized battery hydraulic unit equipped with a built-in overnight charger. Unit has double lifting chains, anti-friction bearing wheels, and special rollers to handle side thrust platform loads.

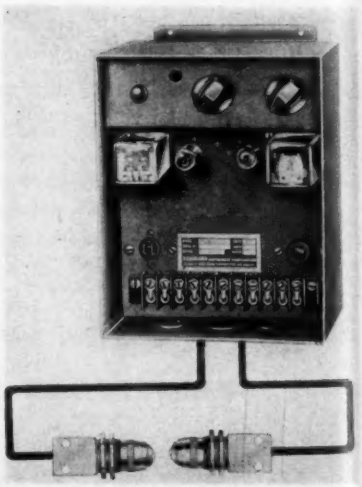
**Langley Mfg. Co., Inc., 913 Cambridge St., Cambridge, Mass.**

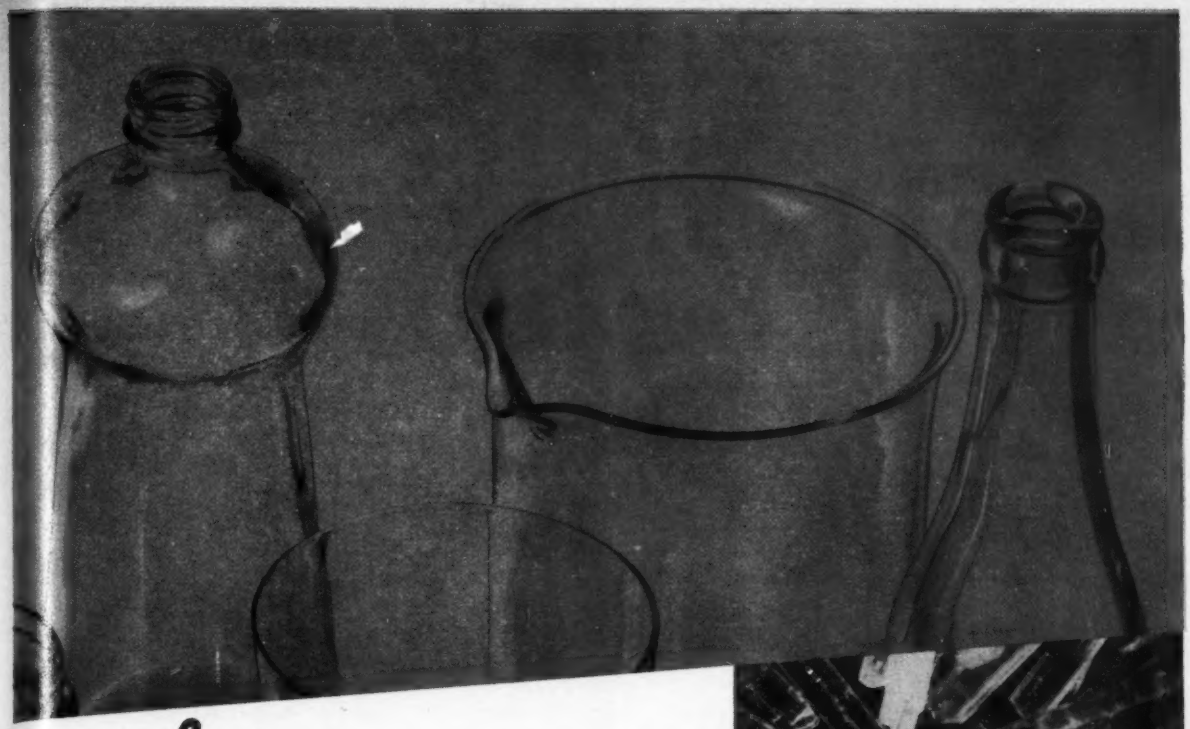
### Photo-Electric Control

Photoelectric controls designed for automatic industrial inspection counting and control. Instrument can be used for production counting, sorting, inspection, traffic control, machine and operator safeguarding, liquid level and bin level control, cut-off control, loop regulation and precision filling. Operation is by beam interruption or by reflection.

System includes a light source, photocell and amplifier interconnected by plug-in terminals and receptacles. Amplifiers are available in tube or transistorized form. Operating range of standard units is up to 20 feet and can be extended to 100 feet, if necessary. Operating speeds are as high as 1000 per minute.

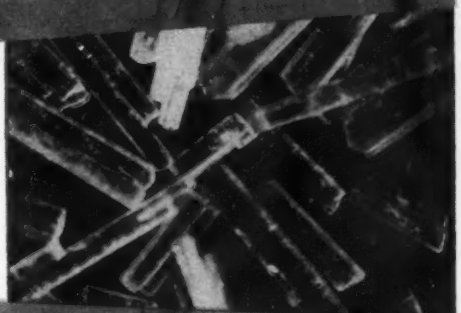
**Standard Instrument Co., New York City**





# fmc SODA ASH...

## *great shape for improved glass!*



Unique, needle-like crystals of mined FMC Soda Ash are perfect for making better, more homogeneous glass.

They won't grind themselves to dust so there are fewer fines to blow over and prematurely choke checkers.

High ratio of surface area to volume helps to give you optimum melt rate and economical furnace temperatures.

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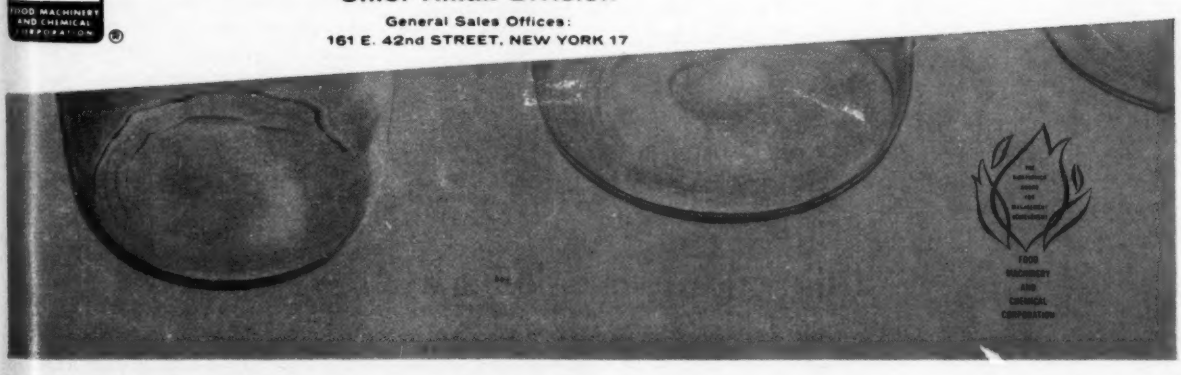


### Thermocouple Connection-Head

A small-size industrial thermocouple connection-head, said to be weatherproof, is designed for high-ambient temperatures and corrosive-atmosphere applications. It is equipped with an all-stainless-steel chain and non-removable screws. A high-temperature refractory terminal block fits B&S number 7 gauge or smaller T/C wires, and B&S number 12 or smaller extension wires. To avoid confusion in polarity, the terminal blocks are clearly marked plus or minus, and the negative terminal is painted red. The head is pressure tight to 125 psi. It is offered with a ¾″ conduit outlet and a choice of five protecting-tube outlet sizes: ¼″, ⅜″, ½″, ¾″ and 1″ N.P.T.

**E. C. Smith Mfg. Co., Inc., Forrest & Hector Sts., Conshohocken, Pa.**

### Structural Plastics

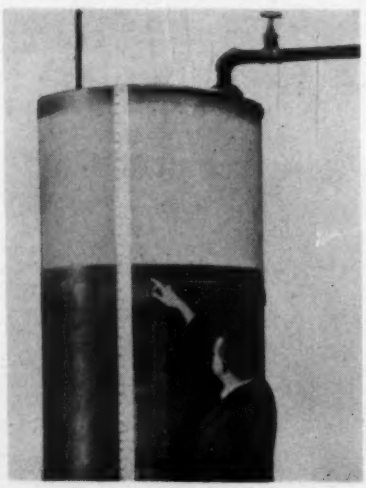
Structural plastics for corrosive applications include complete fume removal systems with component fittings; air washers; process equipment, including molded tanks, fabricated tanks, tank liners, specialty items, and process piping with fittings and valves.

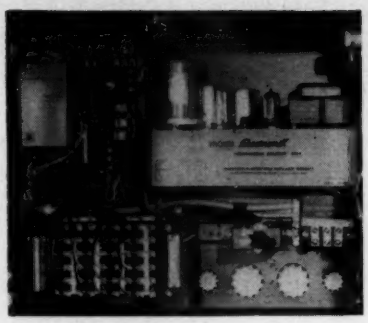
**Argo Plastic Products Co., P.O. Box 3541, Cleveland 18, O.**

### Visible Tank Gauge

A visible liquid-level gauge for reading inventory and controlling batching amounts on fiber glass reinforced plastic tanks. The liquid level is visible through the translucent tank walls, and the volume is read on a calibrated gauge running the height of the tank. Tanks with gauges, suitable for any liquid including corrosives are offered.

**Jones & Hunt, Inc., Adelaide Rd., Gloucester, Mass.**





### Multipoint Recorder

A multipoint strip chart recorder for spot-checking of boiler tube, gearing and transformer oil temperatures in refineries, central stations, laundries and other industries, and monitoring in rocket engine and missile tests, nuclear reactor coolants; also for use in nuclear radiation detection systems. Measurements can be switched from 2 to 3, 4, 6, 8, 10, 12, 16, 20 or 24 points by changing a shorting plug, appropriate indicating and prints wheels, and substituting a new range card, terminal panel and scale changes actuation and range.

**Minneapolis-Honeywell Regulator Co., Wayne and Windrim Ave., Philadelphia 44, Pa.**

### Infrared Transmission Glass

An improved infrared transmission glass for use in optical instruments and high performance IR-guided missiles. In a 2 mm thickness the glass transmits 77 per cent of the infrared at a wavelength of 4.0 microns and 38 per cent at a wavelength of 5.5 microns. At 600°C there is no transmission loss at 4.0 microns and only 13 per cent loss at 5.5 microns. Flat pieces to 12 inches square and one-half inch thick are offered for use in the instrumentation field as in a Schmidt corrector plate. It is also available in hollow shapes, and various sizes and shapes can be mass produced and given an optical finish with standard grinding and polishing techniques.

**Corning Glass Works, Corning, N. Y.**

### Lift Truck

A fork lift truck able to perform right- or left-hand stacking within the confines of a 6-ft. aisle. Pivots a full 180 degrees to permit stacking or load pick-up on either side. Hydraulically-operated outriggers stabilize the lift truck laterally during pivoting.

**Towmotor Corp., 1226 E. 152 St., Cleveland 10, O.**

## CATALOGS RECEIVED

*Grinding spindles.* (4 pages) Specifications, photos and details on precision grinding spindles for diamond wheels; for applications in glass, ceramic, quartz, and carbon.

**THE DUMORE CO., 1300 17th St., Racine, Wisc.**

*Motors.* (12 pages) Publication discusses benefits and features of complete line of fractional horsepower Form G general purpose motors. Capacitor-start, split-phase, permanent-split capacitor, shaded-pole and polyphase motors are included.

**GENERAL ELECTRIC CO., Schenectady 5, N. Y.**

*Vibratory feeders.* (32 pages) Data, specifications, descriptions and illustrations for a line of small, heavy and extra-duty standard electromagnetically vibrated feeders. Information is also included on three pneumatically and hydraulically vibrated feeders for explosive materials, dangerous atmospheres or for light, fluffy materials.

**SYNTRON CO., 156 Lexington Ave., Homer City, Pa.**

*Jetslingers.* (6 pages) Describes machines equipped with short, high-speed belt conveyors for hurling free-flowing bulk materials into areas inaccessible by other mechanical means. Illustrates the suspended, swiveling and wheel-mounted units which are used for hurling material into storage in warehouses, boxcars, holds of ships, bins or upon the ground.

**LINK-BELT CO., Dept. PR, Prudential Plaza, Chicago 1, Ill.**

*Ceramic fiber.* (8 pages) Brochure gives properties, available forms, and current uses of high-temperature ceramic fiber. Uses discussed include: linings for domestic oil burners; linings for induction furnaces; brazing metallic honeycomb sandwich panels in airframe industry, general furnace insulation, and critical applications in missile and space vehicle programs.

**THE CARBORUNDUM CO., Buffalo Ave., Niagara Falls, N. Y.**

*Products and services.* Brochure describes 46 chemical and metallurgical products for use in manufacturing and research. Included are cobalt, nickel, banadium, uranium, zirconium salts, rare earths and thorium chemicals, metals and alloys.

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This Soviet monthly, published for glass and ceramics researchers, technologists and production workers, provides Western scientists with reports on the latest technical advances from the laboratories and refractories of the USSR.

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# NEW BOOKS

FRACTURE, published jointly by The Technology Press of Massachusetts Institute of Technology and John Wiley and Sons, Inc. 1959. Edited by B. L. Averbach, D. K. Felbeck, G. T. Hahn, and D. A. Thomas. $17.50, 646 pages.

This informative book describes the proceedings of an international conference on the atomic mechanisms of fracture held in Swampscott, Massachusetts, April 12-16, 1959. Primarily concerned with the question of what actually occurs on an atomic scale when materials fracture, it represents the opinions of many outstanding research workers in the field. Current theories and experiments are critically considered for the cleavage, ductile, fatigue, and high temperature mechanisms of fracture for metals, ceramics, and polymers. To those most interested in glass technology, the following portions are especially recommended:

a. *The Mechanism of the Brittle Fracture*, by N. P. Allen. Detailed consideration is given to the factors controlling the growth of a crack, particularly the surface energy of the crack, the plastic deformation accompanying crack propagation, and the stress concentration responsible for crack initiation. It is suggested that fracture initiation is not invariably related to disclocation groups formed on yielding.

b. *Classical and Dislocation Theories of Brittle Fracture*, by E. Orowan. Orowan points out the conditions under which brittle fracture can occur in a potentially ductile material. The dislocation theories are said to complement the classical theory dealing with the physical nature of the cleavage strength, in particular, with the role of slip and twinning in crack propagation or nucleation.

c. *Brittle Fracture and the Yield-Point Phenomenon*, by N. Louat and H. L. Wain. From experimental work done on iron and steel, molybdenum, and chromium it is revealed that a simple inversion of the equation relating yield point to testing temperature leads to a condition for brittle fracture. The modified theory of Cottrell locking is further developed and compared qualitatively and, where possible, quantitatively.

d. *Fracture of Ceramic Materials*, by Earl R. Parker. This work describes microscopic observations of deformed and etched MgO single crystals.

e. *Velocity Effects in Fracture*, by H. Schardin. Fracture velocities were measured with various techniques,

(*Continued on page* 236)


# TEN YEARS OF PROGRESS IN THE GLASS INDUSTRY

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**by H. E. SIMPSON,** ALFRED UNIVERSITY

**This comprehensive report was originally published in THE GLASS INDUSTRY in two installments (November and December, 1959).**
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## A.C.S. MEETING

(*Continued from page* 201)

### *Highlights of The Meeting*

There will be a conference of the Ceramic Educational council on Saturday morning and afternoon with president Theodore J. Planje in charge. Papers will be presented on materials engineering, unique laboratory experiments, and application of computers to ceramic development.

On Sunday afternoon at 2 p.m. the National Institute of Ceramic Engineers will meet under president Arthur J. Metzger. The featured speakers will be Patrick M. Dowling of Stanford Research Institute, New York Office, and Fred B. Ortman, former president and chairman of the board of Gladding, McBean & Company. New officers will be installed, and the PACE award for 1960 will be presented. A business meeting will be included.

The Edward Orton, Jr., Memorial Lecture, will be presented on Monday morning by John R. Townsend, special assistant, Office of Assistant Secretary of Defense, Research and Engineering. He will speak on the subject, "Challenge to Ceramics in National Defense."

All Divisions will hold their technical sessions at the Bellevue Stratford hotel, with the exception of the Glass and Electronics Divisions which have their sessions scheduled for the Warwick and Sylvania hotels, respectively.

### Glass Division Officers

New officers of the Glass Division are: Guy E. Rindone (Chairman), Pennsylvania State University, succeeding Frank R. Bacon, Owens-Illinois Glass Co.; J. R. Hensler (Vice-Chairman), Bausch & Lomb Optical Co., succeeding Mr. Rindone, and Secretary Fay V. Tooley (re-elected), University of Illinois.

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## SPECTRAL TRANSMISSION CURVES . . .

(*Continued from page* 206)

Glass 6, of Table II, Fig. 3, is typical of the greens that employ combinations of iron oxide and manganese oxide in concentrations of approximately 1 per cent each. This is typical of wine bottles produced in Europe. While the Dominant Wavelength is well within the usual specifications for emerald green, the purity and brightness values are far outside the limits. Transmission in the ultraviolet for the thicker section is low, while an appreciable transmission is shown by the thinner section. The low transmission in the infrared is of probable practical importance to melting difficulties in a continuous furnace. It is generally understood that these glasses present problems in melting and feeding because of their poor pentration of heat beyond upper layers.

Glass 7, Table II, Fig. 3, is also of the same general type as Glass 6 and is included to show its "blackness", i.e., 9.07 per cent Brightness in 10 mm thickness and its zero per cent transmission at 1050 $\mu$ in the same thickness. This glass apparently contains a large percentage of iron divided between the ferric state, as shown by the 565 $\mu$ position for Dominant Wavelength, and the ferrous state as shown by the zero transmission at 1050 $\mu$.

The less common and relatively new ultraviolet-absorbing emerald green glasses are represented by Glass 8 of Table II, Fig. 2. This glass is Glass 7204 of Sharp's[1] paper. Glasses of this type can be made to have color characteristics within the range of those specified for the normal emerald green. Table III shows the range of color characteristics that may be obtained in the ultraviolet-absorbing emerald green glasses. In this table, the color characteristics are based on 10 mm thickness of glass so as to conform with the thickness requirements of the present specifications. It appears from these data that the color characteristics of these glasses have not as yet become standardized. Judging by the history of the ambers, the Georgia greens, and the normal emerald greens, it may not be long before the color of the ultraviolet-absorbing green glasses will be standardized also.

A new green glass in the United States is illustrated by Glass 9, of Table II, Fig. 4. This glass matches the color of some European wine bottles, but differs from the European glasses in its excellent ultraviolet absorption and in its high transmission in the infrared. This glass certainly provides good protection for contents and should present very few melting problems.

The iron-manganese, amber-green, European counterpart of Glass 9, is shown by Glass 10, Table II, Fig. 4. The European glass, by comparison of color characteristics, has a color concentration about five times greater than Glass 9. In normal thickness, Glass 10 is too dark for many glass container uses. As is typical with these glasses, a very high infrared absorption is shown by Glass 10.

Green glasses represent a wide range of colors and by proper proportioning and selection of coloring ingredients can be made to provide absorption in either the ultraviolet or infrared regions. Because the Dominant Wavelengths are located in the middle of the visible spectrum close to the peak of the visual acuity curve, green glasses do present problems of control but yet offer a very fertile field for the development of distinct and unusual shades. Continued development in this field should add variety to the present color pallet for glasses and should provide new colors for use in product identification and for protection against harmful light rays.

### BIBLIOGRAPHY

1. D. E. Sharp, "Spectral Transmission of Colored Containers Glass," I and II *Glass Industry*, 23 (9), 331-33 (10) 380-83 (1942).

2. "Pharmacopoeia of the United States of America, 14th Revision," Mack Printing Company, Easton, Pennsylvania (1950) p. 4.

3. T. C. Vaughan, "Calculator for Computing Spectral Transmission of Glasses at Different Thicknesses," *Glass Industry*, 25 (6) 278-79 (1944).

4. A. C. Hardy, "Handbook of Colorimetry," Technology Press, Massachusetts Institute of Technology, Cambridge, Mass. (1936).

# Soon To Be Published

# Vol. II. HANDBOOK OF GLASS MANUFACTURE

Volume I of the Handbook of Glass Manufacture was originally published in 1953 by the Ogden Publishing Company. Uninterrupted demand for the book necessitated a second printing in 1957 in order to meet the needs of all those concerned with glass manufacture, technology and engineering. Both the first and second printing of Volume I have been sold out.

As a supplement to the first edition, Volume II of the Handbook of Glass Manufacture will be published on or about June* 1, 1960, and will again be edited by Dr. Fay V. Tooley, Professor of Glass Technology, Department of Ceramic Engineering, University of Illinois.

**CONTENTS . . .**

**Chemical and Instrumental Analysis of Glass**
Francis Glaze, Consultant
John Time, Owens-Corning Fiberglas Corp.

**Optical Properties of Glass: Effects of Radiation on Glass**
Norbert J. Kreidl, Bausch and Lomb Optical Co.

**Scientific Glass Blowing**
Vincent DeMaria, Glass Products Development Laboratory

**Flat Glass Manufacturing Processes**
Roy G. Ehman, Pennsylvania State University

**The Quality Control Chart**
Ronald Wiley, Owens-Corning Fiberglas Corp.

**Electric Melting of Glass**
Larry Penberthy, Penberthy Instrument Co.

**Constitution and Structure of Glass**
Fay V. Tooley, University of Illinois

*It has taken more time than originally anticipated to assemble and edit the material for this new Handbook. Publication plans are progressing, however, and this excellent book will be available as soon as possible. A definite date of publication will be announced next month.

**The Glass Industry**
**55 West 42nd Street, New York 36, New York**

Date.....

Enclosed please find remittance in the amount of $..... to cover the cost of ..... copy(ies) of Volume II of the HANDBOOK OF GLASS MANUFACTURE. Single copy price, $10.00. Order for 5 or more copies, 10% discount. Add Shipping and Insurance charges, domestic 60¢ per copy; foreign 90¢ per copy. Foreign remittance in U.S. dollars.

NAME.....

COMPANY.....

STREET..... CITY..... STATE.....

(*Continued from page* 208)

gas, and its ordinate represents the increase of the heat transfer caused by the substitution. The increase in the heat transferred caused an increase in the temperature of the glass and in the productivity of the furnace. The temperature of the outgoing gas was not significantly altered by the substitution.

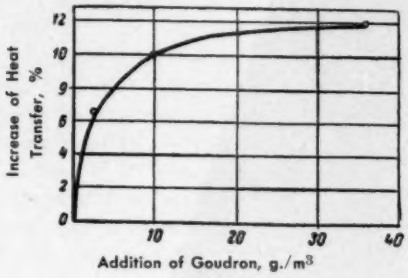



FIG. 3

In another series of experiments in the same furnace, the heat transfer to the glass was kept constant. To achieve this condition, first the quantity of heat transferred was measured in the absence of goudron; then some goudron was introduced and the equivalent volume of gas eliminated; and finally at the constant ratio of goudron to gas the total amount of fuel was reduced until the heat transferred was equal to that without goudron. The saving of gas thus accomplished is demonstrated in Fig. 4. Its abscissa is again the concentration of goudron, while the gas saving in per cent is plotted along the ordinate. It is seen that 30 per cent of gas can be saved in this manner.

In the third series of tests, still in the above furnace, the essential characteristics of glass melting with and without goudron additions were compared. The results are shown in Table I.

**Table 1**

A: Total charge (batch plus cullet), in metric tons.
B: Total duration of melting and fining, in hours.
C: Time during which goudron was introduced, in hours.
D: Total expenditure of gas, in cubic meters at STP.
E: Total expenditure of goudron, in kilograms.
F: Concentration of goudron in gas, in grams per cubic meter
G: Rate of heat evolution, millions of kg.-cal. per hour.
H: Expenditure of standard fuel per ton of glass, in tons.
I: Saving of fuel, in per cent.
J: Decrease in the time of manufacture, in per cent.

| | *Gas* | *Gas plus Goudron* | | | |
|---|---|---|---|---|---|
| | | *Exp. 1* | *Exp. 2* | *Exp. 3* | *Exp. 4* |
| A | 3.1 | 2.5 | 2.8 | 3.1 | 4.1 |
| B | 28.5 | 20.5 | 21.0 | 24.5 | 24.0 |
| C | — | 20.0 | 21.0 | 5.6 | 24.0 |
| D | 44800 | 29030 | 30030 | 39050 | 36145 |
| E | — | 170 | 363 | 85 | 329 |
| F | — | 6.0 | 12.1 | 10.0 | 8.9 |
| G | 1.885 | 1.780 | 1.885 | 1.945 | 1.942 |
| H | 2.475 | 2.095 | 2.020 | 2.200 | 1.625 |
| I | — | 15.7 | 18.4 | 11.0 | 34.4 |
| J | — | 28.0 | 26.3 | 14.0 | 15.9 |

The glass furnace of the other plant used unpurified gas derived from peat. Because of the high moisture content of the peat (average: 51.5 per cent, maximum: 60 per cent), it was impossible to raise the furnace temperature above 1320°C. When goudron was introduced in large drops, objectionable soot formation was observed, and dark glass resulted. When, however, goudron spray produced by steam was used, no soot deposition occurred and the furnace temperature could be raised to 1500°C.

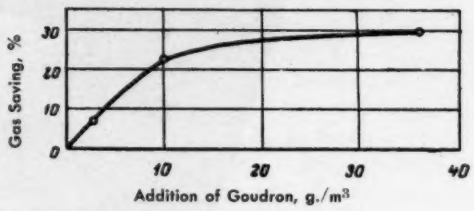



FIG. 4

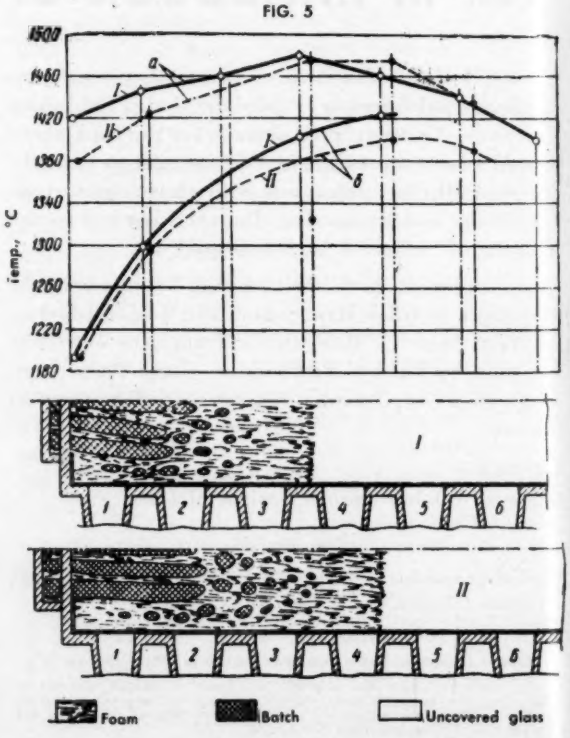
Approximately 100 kg. goudron were used per hour, corresponding to 40-50 grams goudron per cubic meter of gas. The heat transfer to glass was 500000 to 540000 kg.-cal./square meter x hour. The expenditure of "standard fuel" was 0.875 to 0.790 ton per ton glass.

## The Best Temperature of the Melting End of a Glass Furnace

K. K. Vilnis, V. V. Pollyak and M. G. Stepanenko object in *Steklo i Keramika (Glass and Ceramics) 15,* No. 4, p. 1 (1958) to the fashion, common in Russia, to lower the furnace temperature near the charging trough with a view of raising the productivity of the furnace.

This fashion is based on the idea that convection in the glass surface from the line of the highest temperature toward the charging trough accelerates glass formation; the two mechanisms of this acceleration are said to be—(a) when this convection is weak, the batch

FIG. 5



spreads over the whole melting end, and (b) the heat brought to the batch by the convection helps the external heating.

According to the authors, the productivity of a furnace is proportional to the area covered by the batch and to the difference $T_1^4 - T_2^4$, $T_1$ being the average temperature of the furnace above the melting zone and $T_2$ being the temperature of the batch layer floating on glass melt. The area covered by the batch and foam is greater the more batch is introduced in unit time. However, this area cannot be increased indefinitely because the quality of glass suffers when the surface area of glass not covered by batch and foam decreases.

Peyches (THE GLASS INDUSTRY *1947*, 173, 192) believes that only 30 per cent of the surface of the melting end should be covered. The authors found that up to 40 per cent of the area may be covered without lowering the quality of the glass. This determines the upper limit of productivity for the spreading of the batch.

Thus, further increase of productivity can be attained only by raising the furnace temperature. The average temperature above the batch layer rather than the maximum temperature is important. This is proved by the Table in which the amount of glass (kilograms) obtained in 24 hours from 1 square meter of the glass surface covered by batch is given on the basis of measurements on 3 production furnaces in 1954, 1955 and 1957.

| Year | Amount/24 hr. x 1 sq. m. | Average temp. above batch layer | Maximum temp. |
|---|---|---|---|
| 1954 | 3160 | 1440°C | 1470°C |
| 1955 | 2630 | 1418 | 1460 |
| | 2158 | 1385 | 1475 |
| | 1940 | 1374 | 1475 |
| 1957 | 1930 | 1355 | 1470 |

It is seen that the productivity increases with the average temperature and is independent of the maximum temperature.

The rate of convection in the glass melt is determined by temperature gradients in the glass rather than in the upper structure of the furnace, and is not always intensified when the neighborhood of the charging trough is made less hot.

Fig. 5 illustrates the complicated relation between the temperatures of the upper structure (the upper two curves) and of the glass melt (the two lower curves of the upper half of the figure). The ordinate of this upper half is temperature (in °C) and the distance from the charging trough is plotted along the abscissa. The lower half of the figure represents the state of the glass surface in the two furnaces (I and II) when the temperatures indicated in the graph were determined.

Thus, when the temperature of the furnace varied as shown by the upper line I, and the temperature of the melt was as represented by the lower I curve, the batch nearly covered the glass surface up to the second pair of burners, while the foam spread almost to the 4th pair.

As can be seen from Fig. 5, the highest temperature of the glass melt is observed under the uncovered part of the glass surface although the temperature of the upper structure there is lower than above the covered part. Also, the temperatures of the glass between the charging trough and the first pair of burners were almost identical in the two furnaces although the furnace temperatures differed by as much as 40°C. This demonstrates the fact that an increase in the temperature above the batch layer has no effect on the temperature below it and, consequently, cannot affect the rate of convection.

The improvement of productivity by increasing the temperature above the batch layer is limited by the thermal endurance of the refractories. The authors consider 1420°C to be the highest permissible temperature near the first pair of burners, if soda ash is the source of sodium oxide in the glass; when sodium sulfate is used instead of sodium carbonate, this temperature should not rise above 1400°C.

For steady working of a furnace it is imperative to maintain the boundary between the batch-covered and the free glass melt surface as stationary as possible.

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## RESEARCH DIGEST

(*Continued from page* 222)

the layer formed in this way the atmospheric contaminations, greasy substances, etc., are easily adsorbed. As the experiments indicated, by heating the glass to 400°C the contaminations, $H^+$ and $H_3O^+$ ions, are removed and the $SiO_2$ gel thus freed is apt to adsorb certain gases or vapours. Comparative tests of the surface hardness of hydrogen glass and of a glass heated in air to 400°C were undertaken in order to draw conclusions as to the thickness of the surface layer of $SiO_2$ gel. It was found that with hydrogen glass the surface hardness of heated glass is reached at a depth of about 0.6$\mu$.

The possibility of a comparatively deep penetration of the surface gel formation has already been referred to by Eucken. Further experimental results support this supposition.

The $SiO_2$ gel set free by heating adsorbs the metal chloride vapours in contact with the glass surface. The bond may be stronger or weaker, depending on the character of the vaporized chloride, the quality of its metal ion and the dipole momentum of the molecule.

(a) By treating the glass sample with the vapours of chlorides containing metals with ionic radii exceeding 1Å, the surface hardness of the sample remains unchanged, and the condensation on the surface increases at a constant rate with increasing temperature.

It can be assumed that the surface sites occupied by $H^+$ and $H_3O^+$ ions are gradually liberated with increasing temperature, thus activating the gel. The nuclei condensed at the free sites become adsorbed and being super-saturated in comparison to the vapour phase the crystallization by condensation sets in. In the course of the treatment with metal chloride vapours containing the kind of ions already mentioned, the experiments did not supply information on the behaviour of the $Na^+$ ions staying on the surface or the probable diffusion of the $Na^+$ ions towards the surface.

(b) By treating the glass sample with the vapours of chlorides of metals having ionic radii of less than 1Å, the condensation and layer formation increases with the temperature slowly at first and then more rapidly, causing a significant change in the surface hardness conditions of the sample.

## ANALYSIS OF BRITTLE TENSILE . . .

(*Continued from page* 209)

experimentally measured values in the region of fracture which show no Wallner lines on the fracture surface, especially in the regions where fracture starts and ends.

I wish to express my sincere thanks to Professor Schardin for encouraging these investigations and for numerous discussions.

### References

1) Smekal, A.—Ergebn. Exakt. Naturwiss. *15*, 106 (1936) Act. Phys. Austr. *7*, 110 (1953)
2) Schardin, H. and Struth, W.—Glastechn. Ber. *16*, 219 (1938)

## NEW BOOKS

(*Continued from page* 230)

including high-speed photography, schlieren optical methods, and ultrasonic techniques. Glasses exhibit a constant maximum fracture velocity independent of temperature and stress. The results are augmented by many excellent pictures and illustrations of fracture.

f. *The Griffith Criterion for Glass Fracture*, by O. L. Anderson. The work pertaining to the Griffith criterion was reviewed, and it was concluded that this criterion still retains the dominant position in explaining fracture, but is not quantitatively complete. It is suggested that many second-order corrections should be added to the theory, and a number of experiments are required to resolve conflicting evidence on the nature of the cracks.

The entire book comprises twenty-eight papers devoted to the many numerous forms of fracture, and one of the most valuable features of the book is the delineation of future research needs.—H. E. SIMPSON

## DUST CONTROL

(*Continued from page* 203)

surface active agents are required to produce a maximum effect for use in the glass industry. One gallon of compound is mixed with 750 gallons of water to form a solution that effectively wets the finest particles which heretofore would become, and remain, airborne.

Complete systems are now available to the glass industry. Johnson March Corporation of Philadelphia, for example, has carried out extensive research, and the benefits derived from this research concern not only dust control but also other features formerly considered desirable but impossible and thought by many glass technicians to be even more valuable than dust control itself.

Early dust control was directed primarily at foundries and coal mining operations. It has long been recognized that introductions of small amounts of moisture to the batch for dust control could produce other improvements. Many surface active agents are available today, but because of the demanding requirements for purity of all materials going into the batch in glass manufacturing, it is essential that the surface active agents used in this industry have no metallic oxides or other undesirable


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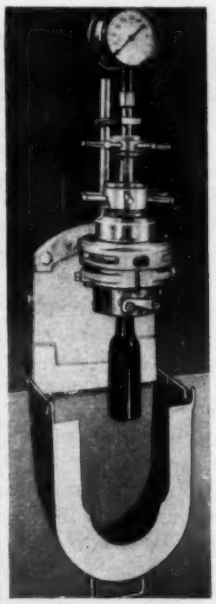

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characteristics. An agent of organic basis, completely volatile at 250°F was developed, and tests made with this material showed excellent control of the dust previously associated with mixing. It was found that by spraying such an agent into the mixer over a given period of time, the resultant mix can be subsequently handled, poured, and moved across transfer points on conveying systems with no evidence of the feathers of fine dust previously unavoidable.

When the moistened batch is fed into the tank the large volumes of dust previously stirred up from the top of the floating, unmelted batch by convection currents in the hot gasses are no longer stirred up; quantities of finely divided additives, previously carried up the stack on air currents, remain in the batch.

This is proven by the fact that the amount of these supplementary materials added may be reduced after such a system is put in operation, with the same effect in the tank which previously required the larger amount. Individual performance records are closely guarded manufacturing secrets of the companies using these systems, but the effectiveness and process improvement is indicated by relatively prompt extension of this system to additional plants of a given company soon after the first system is installed. This effectiveness is noted in all types of glass production (container, flat, hand blown, fiber, and specialty), and produces improvement with all variations in individual formulae. Fine materials remain evenly distributed throughout the batch, and segregation is very substantially reduced or completely eliminated. Fluxing materials seem to become more effective and the batch goes into solution more quickly, because with this type of dust control system the unmelted batch does not float on top of the melt for the distance previously experienced.

With the reduction of dusting in the tank, deposits on checkerwork, overhead tank members, stack walls, etc., are reduced; it appears that longer tank life may be obtained by this dust control.

The above effects are obtained by the addition of approximately 2 per cent moisture to the batch; this amounts to approximately 5 gallons of mixed solution (one part surface active agent : 750 parts water) to each ton of mixed batch. Due to the considerable effectiveness of this treatment close control of the amount of solution added is imperative. Any variations can cause large variations in tank performance. (The addition of the dust control solution with its desirable side reactions has caused some producers to set their controllers for more than the 2 per cent required for dust control.) Equipment has been developed for accurate, fully-automatic control of the amount of moisture added per batch. These systems are in use in many progressive glass plants today; companies with more than one plant have installed these systems in additional plants after experience with the results obtained on initial installation.


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## CONCLUSION

The sources and treatment of dust in the glass industry and the secondary source of dust from power plants have been discussed. Modern methods of treatment may be applied to all types of processes. Automatic controls which reduce the human element to a minimum provide dependable operation. These systems, properly applied, give complete dust control which in turn yields better quality control, better housekeeping, lower equipment maintenance costs, and lower operating costs.

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## INVENTIONS AND INVENTORS

(*Continued from page* 220)

### United States Patents

2,220,765, Hirose et al., Nov. 5, 1940; 2,220,775, Navias, Nov. 6, 1940; and 2,726,161, Beck et al., Dec. 6, 1955.

### Foreign Patents

556,895, Germany, 1932; 703,671, France, 1931; and 719,067, France, 1931.

*Method of joining glass parts. Patent No. 2,866,298.* Filed January 27, 1956. Issued December 30, 1958. No sheets of drawings; none reproduced. Assigned to Owens-Illinois Glass Company by Clarence L. Babcock.

This invention relates to the manufacture of glass articles and particularly to the type where it is found necessary to assemble separate prefabricated glass parts and to join them in some manner, such as by fusing or welding, to form thereby a single item. For example, to form a glass block or a cathode-ray tube it is required to join two prefabricated glass parts to form a single composite article.

The joining of such parts, particularly direct glass-to-glass joining, involves the use of rather high temperatures in order that the glass parts may be fused one to another. The generation of such high temperatures creates conditions detrimental to the glass parts such as deformation of local or extensive areas to be joined as well as permanent stresses which may subsequently result in breakage of the joined parts either spontaneously or from some form of shock.

In order to avoid these objectionable features in sealing or joining glass parts it is proposed to employ a new method of forming the joint between two or more separate glass parts by the use of glass soldering or brazing compositions.

In the following table are listed five glass compositions, the first three of which (No. 1, 2 and 3) are referred to as hard glasses while the latter two (No. 4 and 5) are referred to as low melting glass sealing compositions. The term "hard" glass is intended to include higher melting glass compositions such as the common soda-


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lime-silica glasses to differentiate them from the lower melting, glass-like compositions which are herein referred to as "sealing compositions."

| Number | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Composition: | | | | | |
| $SiO_2$ | 56.6 | 63.43 | 64.38 | 12.7 | ..... |
| $Al_2O_3$ | 1.5 | 1.08 | 4.41 | ..... | ..... |
| CaO | ..... | 0.70 | 0.15 | ..... | ..... |
| MgO | ..... | ..... | 0.10 | ..... | ..... |
| BaO | 10.0 | 9.60 | 12.68 | 3.0 | ..... |
| $Na_2O$ | 3.0 | 6.90 | 7.21 | ..... | ..... |
| $K_2O$ | 10.0 | 10.05 | 9.34 | ..... | ..... |
| $Li_2O$ | ..... | ..... | 0.55 | ..... | ..... |
| PbO | 18.9 | 7.54 | ..... | 72.3 | 71.0 |
| $B_2O_3$ | ..... | ..... | ..... | 12.0 | 17.0 |
| ZnO | ..... | ..... | ..... | ..... | 9.0 |
| CuO | ..... | ..... | ..... | ..... | 3.0 |
| $Sb_2O_3$ | ..... | 0.40 | 0.51 | ..... | ..... |
| $F_2$ | ..... | 0.52 | 1.15 | ..... | ..... |
| ($-O_2$ equivalent) | ..... | −0.22 | −0.48 | ..... | ..... |
| | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| Fiber Softening Point (°C.) | 662 | 637 | 634 | 461 | 404 |
| Annealing Point (°C.) | 457 | 440 | 434 | 403 | 330 |
| Strain Point (°C.) | 425 | 409 | 404 | 389 | 320 |
| Contraction Coefficient Annealing Point to 25°C. ($\times 10^{-7}$) | 113 | 118 | 126 | 107 | 103 |

Two glass parts composed of hard glass #2, for example, can be sealed together using sealing composition #5 into an effective seal which will fulfill the objectives of this invention. These glasses have annealing points of 440°C and 330°C, respectively, with the sealing composition having a contraction coefficient which is approximately 13 per cent less than that of glass #2. The fiber softening temperature of 404°C of sealing composition #5 will permit the fabrication of a joint at near this temperature which is considerably below the annealing point temperature (440°C) of the hard glass #2. It is clearly apparent that sealing composition #5 can readily be applied to sealing glass parts composed of hard glasses No. 1, 2, and 3. Glass #3 has the lowest annealing point (434°C) of the hard glasses which is 30°C higher than the fiber softening point of sealing composition #5. Sealing composition #4 is unsuitable for sealing glasses No. 1 and 2 for cathode-ray tubes because its fiber softening point of 461°C exceeds the annealing points of the two hard glasses, but it may be safely employed where the sealing temperatures are permitted to exceed approximately 460°C. Thus, composition #4 may be used to seal parts composed of hard glass #3 at a temperature of near 460°C.

There was 1 claim and the following references cited in this patent.


**United States Patents**

2,454,607, Leberknight et al., Nov. 23, 1948; 2,643,020, Dalton, June 23, 1953; 2,693,668, Slayter, Nov. 9, 1954; 2,744,034, Dalton et al., May 1, 1956.



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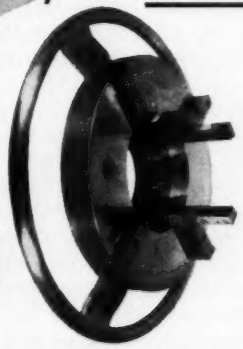

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## Glass Wool and Fiber

*Apparatus for manufacturing mineral wool and the like. Patent No. 2,896,256.* Filed March 6, 1958. Issued July 28, 1959. No sheets of drawings; none reproduced. Assigned to Sealtite Insulation Mfg. Corp.

This invention relates to improvements in apparatus for manufacturing mineral wool and the like.

The stationary stream ring employed in the apparatus of prior applications has been replaced with a novel steam ring attached to and rotatable with the rotor, and in addition, means have been provided in the apparatus for discharging a heating agent directly onto the face of the rotor to thereby apply intense heat at high velocity directly onto said rotor face so as to raise the viscosity of the molten material and minimize the number of unfiberized particles. The use of a steam ring on the rotor makes it possible to have an annular space of controlled width through which the molten material is centrifugally thrown, said space serving as a meter to prevent large globules of glass getting through and into the final product as was formerly possible, and such globules being stopped so that they fall back toward the center of the rotor for further heating. In addition, the rotating steam ring creates a fan-like effect to suck air and gas into its central opening, and the discharging steam creates a syphon effect to pull heated air and gases through the annular space between the rotor periphery and steam ring, which air and gases serve to keep the molten material in molten condition until fiberized.

There were 10 claims and the following references cited in this patent.

**United States Patents**

2,192,944, Thomas, Mar. 12, 1940; 2,587,710, Downey, Mar. 4, 1952; 2,609,566, Slayter et al., Sept. 9, 1952; 2,729,849, Downey, Jan. 10, 1956.

*Apparatus for Forming and Treating Fibers. Patent No. 2,881,471.* Filed December 28, 1954. Issued April 14, 1959. No sheets of drawings; none reproduced. Assigned to Owens-Corning Fiberglas Corporation by Henry J. Snow and Jessee Louis York.

This invention relates to a method and apparatus for forming and treating fibers and, more especially, to a method and apparatus for forming fibers from mineral materials such as glass and applying a binder or coating material on the fibers.

An object of the invention is the provision of an apparatus and method for attenuating streams of glass or other mineral material to fibers by the application of gaseous blasts to the streams of the fiber-flowing material wherein the induced air flow set up or established by the blasts is restricted and a liquid binder is distributed on the newly formed fibers in a confined zone in a manner whereby a minimum of turbulence is existent in the fiber-forming zone with a consequent increase in thermal efficiency manifested by increased production of finer fibers and the fibers are collected in laminar-like orientation to form a mat of uniform thickness having high-strength characteristics and optimim thermal properties.

There were 4 claims and 10 references cited in this patent.

### Sheet and Plate Glass

*Glass Polishing Equipment. Patent No. 2,883,806.* Filed January 20, 1958. Issued April 28, 1959. No sheets of drawings; none reproduced. By Albert J. Pacione.

A principal object of the invention is to provide an improved polishing pad for conventional glass polishing equipment, so designed and constructed as to reduce the amount of felt used, and to simultaneously reduce the likelihood of breakage of glass due to cracking of the polishing felts. A further object of the invention is to achieve the above results by the provisions of an improved pad so designed and constructed that it may be used in connection with polishing machines of the conventional design now commonly employed in the industry.

The present invention departs from the conventional practices outlined above by the provision of a felt polishing pad provided with at least one circumferential notch extending around the pad adjacent the periphery of the polishing block, in the vicinity of the relatively hard "bend" formed by drawing the felt pad around the edge of the metal block. It has been found that such notching of the marginal edges of the felt largely overcomes the premature deterioration of the pads which otherwise occurs, yet does so without sacrifice of the wear resistant qualities of the relatively hard "bend" portion at the edge of the pad.

There were three claims and the following references cited in this patent.

#### United States Patents

391,198, Wadsworth, June 16, 1908; 1,798,633, Rotheram, Mar. 31, 1931; 1,946,355, Miller, Feb. 6, 1934.

*Glass grinding and polishing apparatus. Patent No. 2,882,652.* Filed February 24, 1958. Issued April 21, 1959. No sheets of drawings; none reproduced. Assigned to Pittsburgh Plate Glass Company by William Owen.

This invention relates to apparatus for surfacing plate glass and has for its primary object the provision of an improved glass surfacing apparatus having a relatively flexible and cushioning coupling between a vertical drive spindle and a grinding runner, which coupling allows relative angular misalignment between the spindle and the runner so that the runner may adjust itself to the surface of the glass and minimize runner cuts and breakage in the glass.

There were 4 claims and the following references cited in this patent.

#### United States Patents

1,698,365, Hitchcock, Jan. 8, 1929; 1,984,205, Vinella, Dec. 11, 1934.

### Tube and Cane Machines

*Tubular glass containers such as ampoules, phials and the like. Patent No. 2,896,807.* Filed February 19, 1954. Issued July 28, 1959. No sheets of drawings; none reproduced. Assigned to Glass Containers (Medical) Limited, by George Stanley Shaw.

The present invention comprises a method of manufacturing glass ampuls made of neutral glass the ratio of the thickness of the ampul wall at the neck to the


**DUAL PURPOSE POLAROID* POLARIMETER AND POLARISCOPE MODEL NO. 204**

*A.S.T.M. designation #C 148-59T*

*Horizontal and Vertical Views*

Analyzer is mounted within calibrated circle reading clockwise from 0° to 180° and counter-clockwise from 0° to 180°.

For use as a polariscope, the analyzer is set to read zero. The polarizing field is a typical red-purple and strain is seen in characteristic colors for tension and compression.

* T.M. Reg. U.S. Pat. Off. by Polaroid Corp.

Polarizing field 10" diameter.
Binocular analyzer. The shaded eyepiece makes the use of the instrument practical on the open floor with regular shop illumination.
Distance between analyzer and polarizer 16".
For use as a polarimeter, the sensitive tint plates are swung out of the optical path by a finger movement; this movement automatically brings the quarter wave plates into the optical path. The polarizer now appears as a typical dark extinction field and a strained glass specimen is seen as a shaded black to white area. To measure this strain, the calibrated analyzer is rotated until the light area turns to maximum darkness. The reading of the calibrated circle, in degrees, multiplied by 3 (or more precisely 3.03) is equal to the retardation in millimicrons, of that strained area. The instrument may be used in any position from the vertical to the horizontal.

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outside diameters of the neck is maintained at not less than 8 per cent and in the case of ampuls made of glass of more or less inherent strength or resistance to breakage than neutral glass the said ratio is maintained at not less than 7 per cent or 9 per cent respectively and in which the ampul is preweakened at the neck, preferably by transversely scoring the neck, to an extent only sufficient to facilitate intentional breakage of the ampul at the neck by the application of a bending moment thereto.

In general it is to be preferred that the thickness of the glass wall at the neck should be maintained at not less than 10 per cent and not greater than 15 per cent of the external diameters of the neck and this is particularly so in the case of small ampuls with necks of the order of 4 millimeters to 6 millimeters in external diameter. It is desirable in the case of small ampuls having a relatively small diameter at the neck that the thickness of the wall at the neck should be maintained well above the lower limit of 8 per cent even though satisfactory results can be achieved with wall thicknesses as low as 8 per cent of the neck diameter.

There were 5 claims and 10 references cited in this patent.

### Miscellaneous Processes

*Presealing flush machine for incandescent lamp bulbs. Patent No. 2,816,579.* Filed February 27, 1953. Issued December 17, 1957. No sheets of drawings; none reproduced. Assigned to Westinghouse Electric Corporation by Law L. Armstrong, George Meister, and Stanley A. Lopenski.

The present invention relates to the manufacture of incandescent electric lamps and, more particularly, to a presealing flush machine for incandescent lamp bulbs.

The presealing flush machine is provided with a plurality of heads which index from station to station. The bulbs are loaded on the heads, etched, heated to approximately 450°C, and continuously flushed with either nitrogen or air-heated to a temperature above 250°C, and finally nitrogen-filled prior to their "hot" transfer to the sealing portion of a conventional "Sealex" machine.

Further, the sealing portion of the "Sealex" machine is modified so that nitrogen flows thru the unsealed lamp in a plurality of preliminary fire-heating positions (to prevent oxidation of internal parts) and into the sealed lamp at a seal-molding position (to form the seal and further protect the cleaned parts). The conventional exhaust portion of the "Sealex" machine is then capable of a higher production rate and produces an improved quality of product due to the prior removal of water vapor and deleterious gases from the bulbs during presealing flush thereof and maintenance of clean mount parts during sealing.

The machine thus removes water vapor and other deleterious gases from bulbs prior to sealing and fills the heated bulbs with an inert gas prior to a "hot" transfer to the sealing portion of an adjacent modified standard "Sealex" machine, which increases the production rate and improves the quality of incandescent lamps.

There were 5 claims and thirteen references cited in this patent.

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# LETTERS TO THE EDITOR

*This column is provided as a literary meeting place for readers who wish to share ideas, express opinions, and ask questions on glass, its manufacture and its applications. Your letters are most welcome.*

### Fiber Glass or Fiberglass?

Dear Sir:

We believe definitely that in utilizing the term fiber glass as a general de-

scription for the broad product classifications as produced by our industry that it should be spelled out as two separate words . . .

It is therefore, our recommendation that you use the description as two complete separate words.

F. H. MAY, JR.
Vice President
Johns-Manville
Fiber Glass Inc.

Dear Sir:

. . . there has been a widespread misuse of the proper or generic term fiber glass.

We agree . . . in preferring "fiber glass" as the descriptive term for the material we manufacture.

W. G. COLE, JR.
General Manager
Fiber Glass Division
Ferro Corporation

Dear Sir:

Your recent articles on *Ten Years of Progress in the Glass Industry* and *The Glass Industry—1959* were very interesting. I notice between the former published in November (1959) and the latter published in February (1960), however, that you have changed the spelling of "fiber glass" to "fiberglass."

I do not believe the one-word spelling of our industry is correct, though it is a very common mistake. I am sure if your articles use the correct spelling you will help to overcome this misconception.

F. M. WRIGHT
Assistant to the Manager
Process and Quality Control
Fiber Glass Division
Pittsburgh Plate Glass Company

*The change in spelling in that issue was deliberate. Because varied spellings of the generic term for fiber glass have appeared from time to time in press releases, company letters, and in formal print, we wanted to determine once and for all the accepted spelling in the industry.*

*When you get right down to it, what determines "correct" spelling? Or "proper" speech? Of course special committees are frequently empowered to establish standards in technical language, but every-day usage is probably the most powerful, single force. By contacting the major fiber glass manufacturers we have received both written and verbal agreement on the two-word spelling. Accordingly,* THE GLASS INDUSTRY, *hereby goes on record as favoring "fiber glass" as the correct form based on the combined opinion of fiber glass manufacturers.*

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